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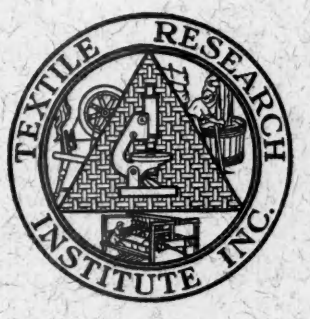

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TEXTILE RESEARCH JOURNAL

VOL. XVI, No. 2 February, 1946

Mechanical Properties of Textiles, IV

Richard Stein,* George Halsey,* and Henry Eyring**

Contribution of the Textile Foundation and Princeton University, Frick Chemical Laboratory, Princeton, New Jersey

IN the previous papers of this series † methods have been presented for the analysis of the stress-strain curves of textile fibers. Their behavior has been described in terms of a three-element mechanical model (Figure 1) consisting of a spring in parallel with a Maxwell element which, in turn, is composed of a spring and a non-Newtonian dashpot in series. The extension of the springs was shown to be related to the uncoiling of the polymer molecules from their random or equilibrium positions against the restoring tendencies of potential energy and entropy; the slipping of the dashpot was explained in terms of the rate process of the slipping of the segments of the molecules past each other. The detailed molecular theory of these unit processes is the subject of previous [1, 2] and future papers.

These elements may be characterized by four constants—namely, the force constants of the two springs, and two constants of the non-Newtonian dashpot. It is of interest to attempt to describe the complete behavior of the fiber in terms of these constants in the various testing procedures to which it is subjected. In this way the differing mechanical behavior of fibers as affected by the various external conditions, such as humidity, chemical action, and past mechanical history, may be ascribed to the particular one of the four basic parameters.

It should be noted, however, that each of these elements actually represents a whole distribution of molecular elements, so that its characteristic constants are actually average values. The real elements

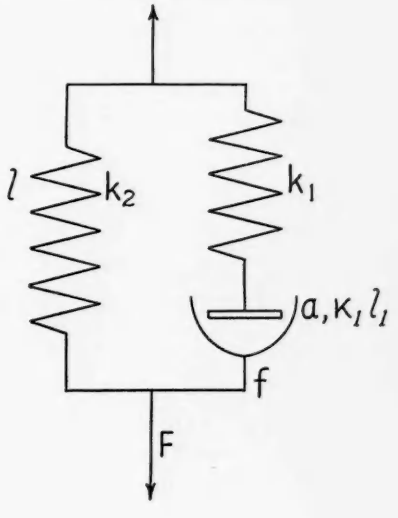

FIG. 1. *The three-element mechanical model used as a model for describing the visco-elastic behavior of textile fibers.*

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** Director of Fundamental Research, the Textile Foundation.

† Paper I appeared in the September, 1945, issue, page 295; Paper II, in the December, 1945, issue, page 451; Paper III, in the January, 1946, issue, page 13.

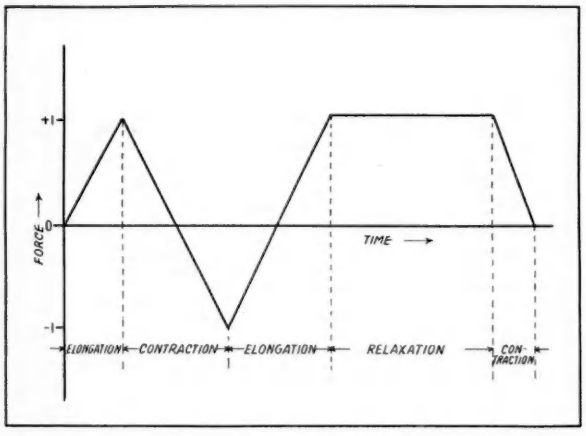

FIG. 2. *The force-time curves for a single open spring on being subjected to a successive series of elongation operations at a constant elongation rate.*

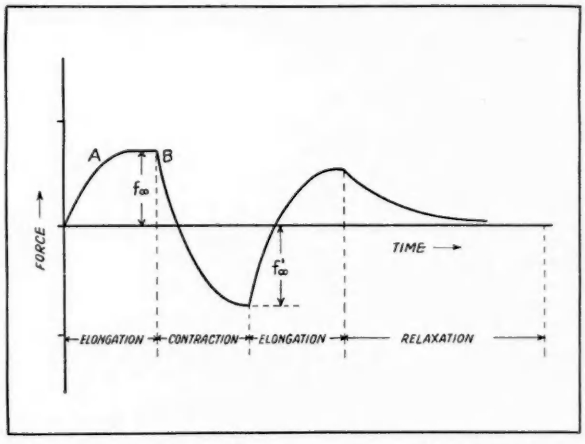

FIG. 3. *The force-time curve for a Maxwell element on being subjected to a successive series of elongation operations at a constant elongation rate.*

contributing to this distribution are dependent upon the nature of the experiment in which the properties are measured. For example, dashpots having long relaxation times do not contribute anything in experiments performed during short periods of time. Therefore, the nature of the experiment must be considered in comparing constants which are determined in different ways.

In the third paper of this series [3] the analysis of the three-element model (developed principally in the first paper [1]) was discussed in terms of generalized experimental constraints. It was shown that solutions are obtainable when the force is a linear function of elongation and time. The analyses were extended to describe experiments which were continued over more than one loading or elongation cycle which successfully explained hysteresis phenomena. It is the purpose of this paper to elaborate upon this method as applied to the analysis of the stress-strain curves of several rayon fibers obtained at constant rates of elongation as produced by the Sookne-Rutherford autographic balance [4].

As has been shown, the analysis may be accomplished in a simple, graphical manner. This may be illustrated by considering first the behavior of each element constituting the model.

For a spring, the force will be a function of the length and will be independent of time. In the case of a simple, single Hookean spring, the function will be linear. Figure 2 shows a plot of the force on such an element through the successive operations of extension, contraction, extension, relaxation, and contraction at constant rate of elongation. The region of negative force represents a state of compression which would not be realizable if the spring were the only element constituting the fiber. Actually, however, when in combinations with other elements, a single element may exist in a state of compression as long as the total force on the whole fiber remains positive. In the more complex case of a non-Hookean spring, a similar curve (departing from linearity) results, and subsequent parts of the cycle may be constructed from the first half-cycle by translation along the time axis and reflection across it to negative forces. This departure from Hooke's law may result from (*a*) the individual "molecular springs" obeying a non-linear force-elongation law (such as the rubber elasticity equation [3]), (*b*) the conversion of springs to dashpots at higher elongation, (*c*) the inclusion of springs at greater elongations which are slack at the lower elongations, (*d*) the complete "straightening out" or orientation of some of the molecular springs, and (*e*) the destruction of structure by the rupture of primary bonds and permanent cross-links at high elongations. The last type of non-Hookean behavior may be irreversible and not subject to treatment by this analytical method. It has been considered for the case of rubber-like systems by Tobolsky and Andrews [5].

For a single dashpot, the force is independent of elongation but is some function of the velocity. For a Newtonian dashpot, the velocity varies linearly with the force, while for increasing non-Newtonian character there is a tendency for a yield point to develop, below which an increase in force does not have a great effect on velocity and above which a small increase in force results in a large velocity change.

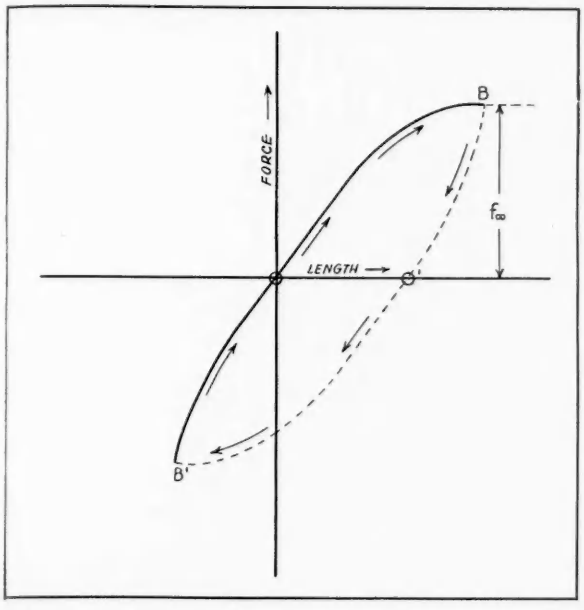

FIG. 4. *The force-length working curve describing the hysteresis behavior of the Maxwell element at a constant elongation rate.*

In the light of these considerations, a Maxwell element should initially have a force-elongation curve (at constant elongation rate) which is characteristic of the spring, but which should show greater elongations at higher forces as a result of increasing amounts of dashpot slipping. Also, the force on the unit will not be independent of time but will tend to decrease as the force on the spring is relaxed by the slipping of the dashpot. Therefore, such a unit, upon being subjected to the same series of operations as was the spring of Figure 2, will produce the force-time curve of Figure 3.

The somewhat arbitrary position, A, where the force on the dashpot causes it to begin to slip at a rate equal to the rate of elongation, is usually called the "yield point." The definiteness of this position is dependent upon the non-Newtonian character of the dashpot. The limiting force, f_∞, and its variation with rate of elongation are also dependent upon the degree of non-Newtonian character. These two qualities may be used in the determination of the α and K in the equation of motion of the dashpot

$$\frac{dl}{dt} = K \sinh \alpha f.$$

At the point, B, the dashpot is slipping at a rate equal to the rate of elongation, so that if elongation is suddenly stopped the spring will be relaxing momentarily at a rate equal to the initial rate of elongation, ρ. Therefore, the force should decrease instantaneously with a rate, $-k, \rho$, which is equal to the initial increase of force at the origin. However, in the hypothetical experiment, elongation has not only been stopped but has been reversed, so that beyond point B the length of the spring is decreasing at a rate, $-\rho$, because of the reversal of direction of travel in addition to the rate, $-\rho$, due to the relaxation of the dashpot. Therefore, the slope of the force-time curve at B should be twice that at the origin.

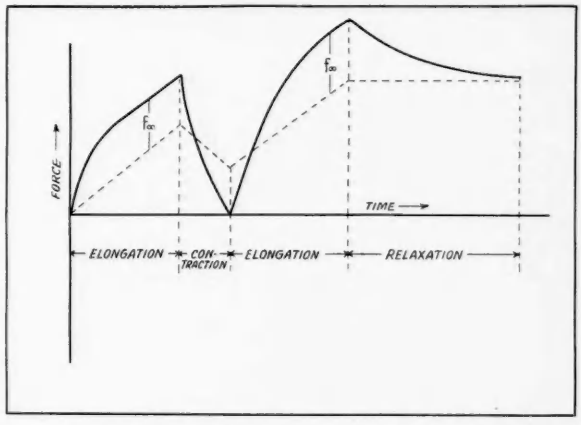

FIG. 5. *The force-time curve for the complete three-element model on being subjected to a successive series of elongation operations at a constant elongation rate.*

In Paper III, it has been demonstrated that this behavior may be described by means of a so-called "working-curve" (Figure 4). The curve, as it is shown here, may be constructed from Figure 2 by folding the recovery part of the curve back upon the elongation part so as to represent a plot against length rather than time. It is seen from the resulting hysteresis loop that at zero force the length has not returned to its initial value and that it is therefore necessary to carry the cycle on through its negative half in order to restore the initial conditions. Since the loop is symmetrical, the dashed portion may be omitted; this omission should not be forgotten. As a consequence, one must now jump over to corresponding force regions on the other side of the length axis every time that one reverses the direction of travel.

The extension to the complete model having this Maxwell element in parallel with the open spring follows (Figure 5). It should be noted that the operations are shown only for regions of positive forces because of the impossibility of compressing a fiber. For this reason, it is not always possible to

complete the hysteresis loop, in which case the fiber is not immediately returned to an equilibrium position upon completion of an extension and recovery cycle. Its failure to return, as has been pointed out in Paper III, should not be confused with "permanent set" or any other type of structural change brought about by the mechanical working of the fiber. This temporary set is the type which is removed by wetting the fiber.

The dashed curve of Figure 5 represents the force on the open spring, whereas the full curve represents the force on the complete model. Thus, the difference between the two curves represents the force on the Maxwell element as represented by its working curve. It is this fraction of the force that may be relieved by relaxation of the dashpot.

In the actual analysis, one is confronted with the task of working this synthesis of the final curve backwards. This is usually accomplished by first determining the characteristics of the open spring, and then subtracting its curve from the complete curve in order to obtain the working curve for the Maxwell element. The analysis of this working curve has been discussed in detail in Paper I.

If the open spring is linear, the determination of its constant from the final curve is relatively simple. Since, as we have seen in Figure 3, the Maxwell element does not contribute materially to the slope of the stress-strain curve after its critical point has been reached, its slope in this portion is due entirely to the open spring and is equal to its force constant. For a non-Hookean open spring, where a shape factor must also be determined, this procedure is somewhat more difficult. Its applicability will be facilitated, however, if the experiment is performed at a very low rate of elongation so that the critical point occurs early in the curve.

In addition to the determination of the force (and shape) constant of the open spring, its condition at the beginning of the experiment must be established. It may well be that it is not initially at equilibrium, owing to strains in manufacture or in mounting. The open spring may be in a state of tension (or compression) which is compensated by a corresponding force of compression (or tension) of the spring of the Maxwell unit. This condition is, of course, internally unstable and will eventually be relieved by the slipping of the dashpot. However, under conditions of low humidity and extreme non-Newtonianness, the dashpot is extremely stiff to small forces, and the attainment of equilibrium may be very slow.

There are two methods that may be applied to determine the initial displacement of this spring. The first method involves the assumption that the yield force for the dashpot is the same in either direction. Therefore (referring to Figure 5), the saw-tooth lattice for the open spring is moved up or down so that the yield force in the forward direction, F_∞, equals the yield force in the reverse direction, F'_∞. When this condition is fulfilled, the intersection of the dashed spring curve on the force axis determines the initial force on the spring.

The second method involves hunting for the position of zero relaxation. That is, as is illustrated in Figure 5, the total force tends to relax to the value of the force on the open spring, so that one may determine this position by adjusting the total force to a value above or below this value, and by observing the direction of relaxation. The application of this technique is illustrated with one of the actual experimental curves.

Experimental Data

Two types of rayon * were selected for the experimental work. One was a poorly oriented textile rayon which was especially prepared with a large fiber size (6 denier) in order to facilitate measurements at appreciable loads, while the other was a highly oriented experimental rayon having a 2-denier fiber.

Single fibers of approximately 6 centimeters in length were mounted between hooks with DeKhotinsky cement and suspended in test tubes in the manner illustrated in Paper I. These fibers were "conditioned" with respect to humidity by desiccating them over proper concentrations of sulfuric acid for at least a week. The moisture was "sealed into" the fiber during the run by filling the test tube with mercury that was conditioned in the same way as the fiber.

The fibers labeled "zero humidity" were dried under vacuum (rotary mechanical pump) at 40° C for about 12 hours. The mercury was dried simultaneously, and the fibers were "sealed" with mercury while under vacuum.

Stress-strain curves were obtained with the autographic balance at two rates of elongation (1.85×10^{-4} cm./sec. and 4.8×10^{-3} cm./sec.), differing from each other by a factor of about 25.

* The two types of rayon were kindly supplied by Drs. W. E. Roseveare and Elijah Hicks of E. I. du Pont de Nemours & Co.

TABLE I

Run No.	Fiber*	R.H. (%)	Rate of elongation (cm./sec. $\times 10^4$)	k_1 (Maxwell spring) $\times 10^{11}$ (dynes/cm.^{2})	k_2 (open spring) $\times 10^{11}$ (dynes/cm.^{2})	β (from relaxation)	β (from curve shape)	f_∞ (gr.)
1	A	~0	1.85	3.70**		—	—	—
2	A	4.2	1.85	1.08	1.83	46	20	0.60
3	A	35	1.85	0.98	1.21	28	90	0.67
4	A	88	1.85	—	1.42	300	—	1.19
5	A	~0	48	3.76**		—	—	—
6	A	35	48	2.12	0.69	850	200	1.73
7	B	~0	1.85	1.43**		—	—	—
8	B	88	1.85	0.65	0.098	90	very large	0.84
9	B	~0	48	1.18**		—	—	—
10	B	4.2	48	0.06	0.15	very large	60	5.95
11	B	35	48	0.03	0.093	300	5	1.18
12	B	88	48	—	0.060	—	—	—

* Fiber A is the highly oriented 2-denier fiber experimental rayon; Fiber B is the poorly oriented 6-denier fiber textile rayon.
** For these vacuum-dried samples, there was apparently no dashpot slippage, so that k_1, k_2, β, and f_∞ could not be separately resolved. The spring constant given is that of $k_1 + k_2$.

In Table I, the results of runs with these fibers at several humidities are summarized. The spring constant of the open springs, k_2, is given in units of dynes per 100 percent change in length per square centimeter of cross-section. Because of the extreme stiffness of the dashpots of the vacuum-dried fibers, a yield point was not reached, and it appears that there was no dashpot slippage. Therefore, no value of k_2 could be measured from a final slope for these fibers and a value of $k_1 + k_2$, calculated from the initial slope (which remained essentially constant throughout the elongation), is given. Since the values of the spring constants appear to be relatively independent of humidity, the values of k_1, the approximate spring constant of the Maxwell element spring, may be obtained by subtracting the measured k_2 values for those fibers from the $(k_1 + k_2)$ values for the corresponding vacuum-dried fibers.

The k_1 values given in the table are calculated from the initial slope corrected for dashpot slippage in the manner indicated in Paper I.

The values of β given in Table I are the reduced parameters of the non-Newtonian Maxwell element. They are determined by the methods described in Papers I and III from the rate of relaxation, and the shape of the stress-strain curve in the vicinity of the yield point. It is seen that their variation is not consistent. It is believed that this lack of consistency is due either to lack of uniformity among the fibers, or instrumental drift in the autographic balance during the long relaxation runs. It is planned to repeat these measurements using the same fiber sample for the runs at the various humidities and elongation rates, or by employing a statistical sampling procedure.

An interesting observation may be made from the limiting force values, f_∞, for two similar fibers run at the same humidity but at different elongation rates. For example, with runs 3 and 6, the limiting force values are 0.67 at the slow rate and 1.73 at the fast rate. The ratio of these limiting forces is 2.6 to 1 while the ratio of elongation rates is 26 to 1. For Newtonian flow, the limiting force ratio should be equal to the elongation rate ratio. While the experimental error in these force measurements is admittedly large, it is inconceivable to the authors that this behavior could be explained by any but an exponential viscosity law.

Some of the typical stress-time curves are reproduced in Figures 6, 7, 8, and 9. The curve in Figure 6 illustrates the validity of the interpretation of the shape of these curves, as well as one method of establishing the initial condition of the springs. It is seen that if one traces the course of the force on the open spring as predicted from the limiting slope for the first half cycle (assuming arbitrarily that it is initially under zero force), a horizontal line could be determined at the beginning of the relaxation toward which the total force should asymptotically approach. In this experiment, the total force was adjusted to a value somewhat below this, and it was seen that relaxation proceeded upward. Then the total force was adjusted to a value somewhat above the line, and, as expected, relaxation proceeded downward. The total force was then adjusted to a value approximately equal to that on the open spring, and

it was observed that over a period of 70 minutes no relaxation occurred. It is conceivable that there may have been an initial force on the spring. If this were true the predicted line of no relaxation would not have agreed with the one determined experimentally. Then the whole lattice of zigzag lines representing the traces of the force on the open spring would have to be moved up or down until it did agree. The intersection of the beginning of this lattice with the force axis would then equal the initial force on the spring.

In Figure 7, the excellence of the fit which is possible by these methods is demonstrated. For this run, it was necessary to assume a small initial force on the spring. From the difference in force between the open spring curve and the total force curve in the first half-cycle the working curve for the Maxwell element was constructed. From this the remainder of the run was predicted. The circles represent the predicted force values, which agree remarkably well with the experimental values. In the adjacent relaxation curve (which is plotted against log time) it is

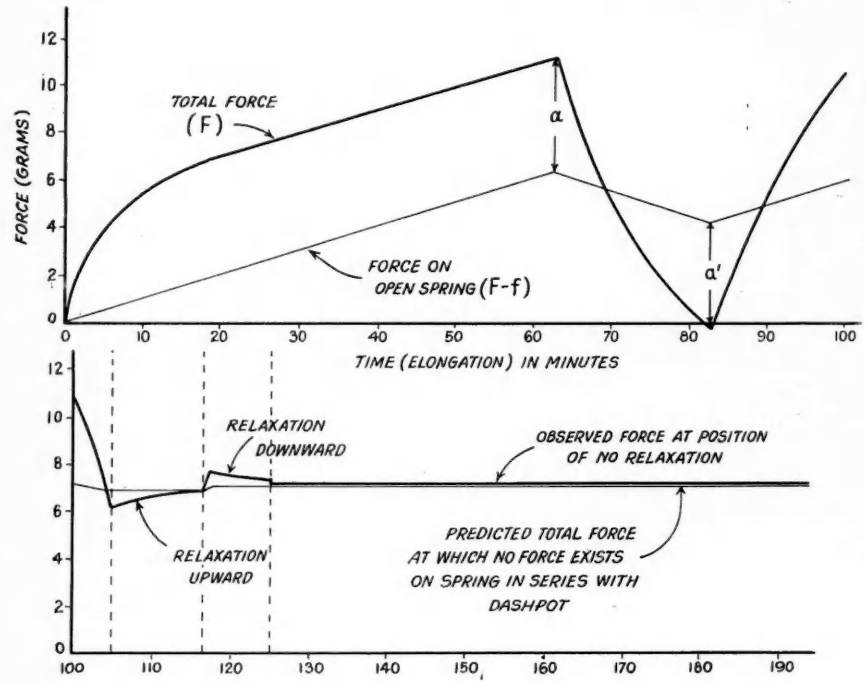
FORCE (GRAMS)
TOTAL FORCE (F)
FORCE ON OPEN SPRING (F-f)
α
α'
TIME (ELONGATION) IN MINUTES
RELAXATION DOWNWARD
RELAXATION UPWARD
OBSERVED FORCE AT POSITION OF NO RELAXATION
PREDICTED TOTAL FORCE AT WHICH NO FORCE EXISTS ON SPRING IN SERIES WITH DASHPOT

FIG. 6. *An experimental force-time curve at constant elongation rate illustrating the method of "hunting" for the point of zero relaxation. The fiber is a 6-denier fiber textile viscose rayon conditioned at 4.2 percent humidity and elongated at* 1.9×10^{-4} *cm./sec.*

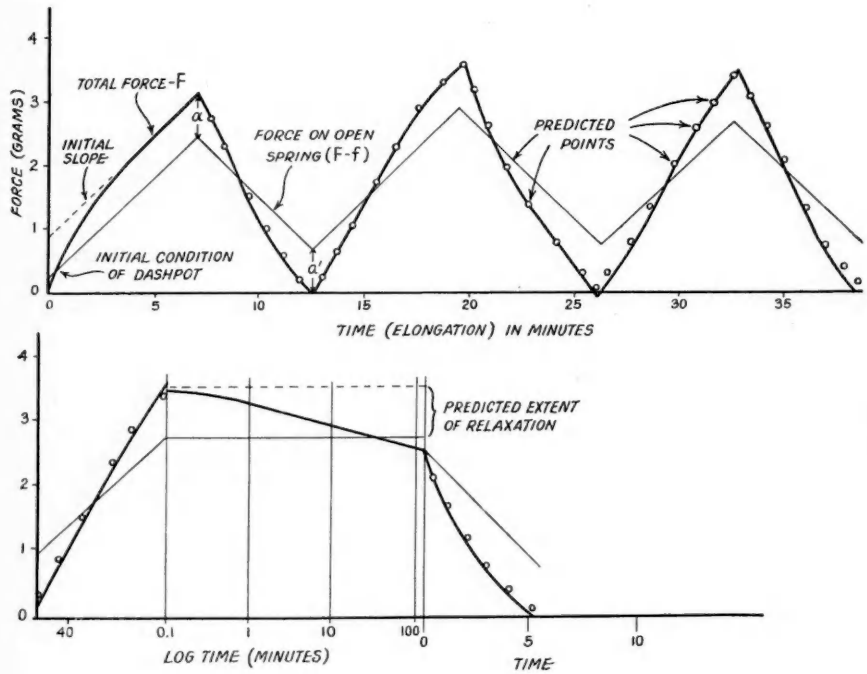

FIG. 7. *An experimental force-time curve at constant elongation rate illustrating the method of analysis of the curve and its success in predicting the curve for succeeding operations. The fiber is a 2-denier fiber highly oriented experimental viscose rayon conditioned at 35 percent humidity and elongated at* 1.9×10^{-4} *cm./sec.*

seen that the actual amount of relaxation is slightly more than the predicted amount at the end of 100 minutes. If one assumes that the relaxation has been completed at the end of this time (before starting upon the recovery curve which immediately follows the relaxation), and assumes also that there is then zero force on the Maxwell element, the predicted points again are in good agreement with the experimental curve. It is also seen that the relaxation curve is straight over almost 3 cycles of log time. Curves have at times been obtained that were straight for as long as 4 to 5 cycles. A pure Newtonian curve is not straight for longer than 1½ cycles, so that this is an indication of non-Newtonianness or a distribution of relaxation times, or both.

Figure 8 is another example of a fit of this type for a low-orientation rayon textile. The relaxation curve in this case becomes flat approximately at

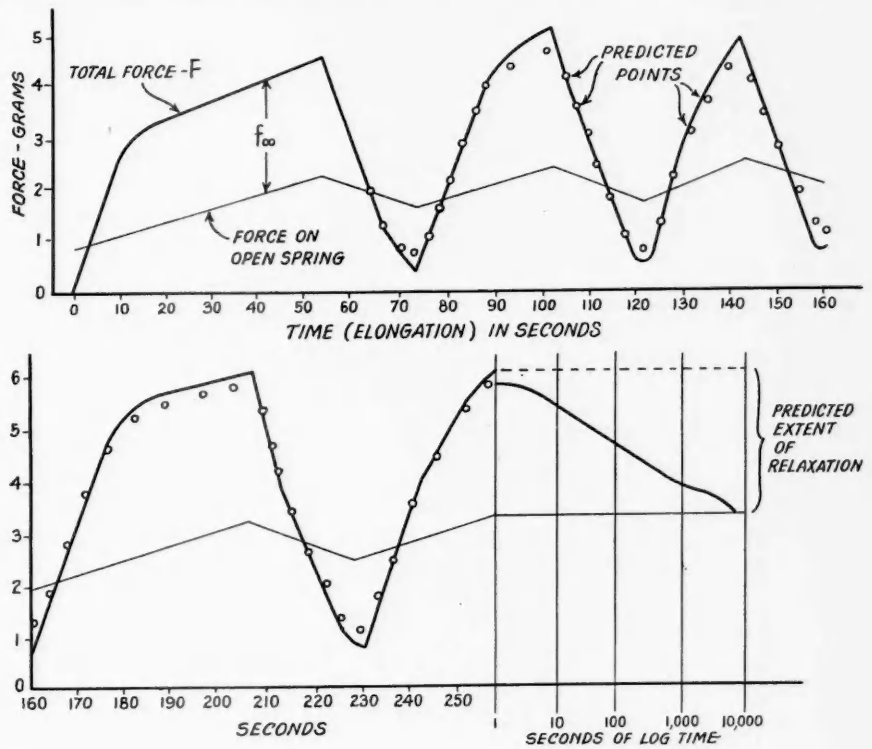

FIG. 8. *Another example of the method of curve analysis. The fiber is a 6-denier fiber textile viscose rayon conditioned at 35 percent humidity and elongated at* 4.8×10^{-3} *cm./sec.*

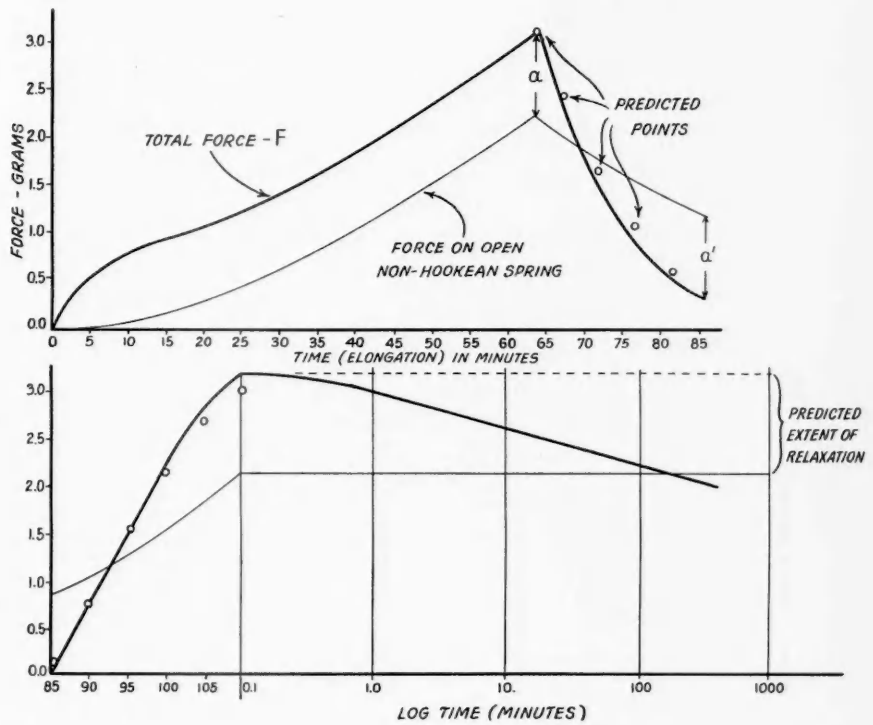

FIG. 9. *An experimental force-time curve at constant elongation rate illustrating the method of analysis in a case of non-Hookean behavior. The fiber is a 6-denier fiber textile viscose rayon conditioned at 88 percent humidity and elongated at* 1.9×10^{-4} *cm./sec.*

the predicted force, but then, after about 5,000 seconds, bends down again. This probably indicates either the onset of the effect of a new relaxation time, or of a small constant drift in the balance circuit which would appear in this manner on a logarithmic plot.

In Figure 9, the effect of a non-Hookean spring is apparent. This curve represents an elongation of about 10 percent of a poorly oriented, high-humidity fiber at a slow rate. These conditions are ideal for the manifestation of the influence of a distribution of chain lengths between crystalline areas, which is a condition expected to lead to the observed non-Hookeanness. The calculated points in this case are seen to fit experimentally, as in the previous examples.

Thus again it has been shown that the simple model of a spring and dashpot in parallel with a spring accounts with remarkable fidelity for stress-strain behavior over several cycles of lengthening and shortening, even when these strains approach the breaking point. With improvement in experimental technique it is expected that the irregularities in β will be reduced to a minimum and that the remaining deviations will permit us to extend our model. A model with additional elements will more exactly approximate reality, but at present the experimental procedure is not precise enough to justify such an extension.

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A Study of Cotton Blending*

Simon Williams and Jack D. Towery†**

Abstract

Twenty-nine different blends involving two-bale mixes of two varieties of cotton—namely, (1) Hi-Bred, ranging in staple from $1\frac{3}{16}$ to $1\frac{5}{16}$ inch, and (2) Bobshaw No. 1, ranging in staple from $1\frac{1}{16}$ to $1\frac{3}{16}$ inches—both varieties represented in grades "middling white" to "strict good ordinary white," were studied. The effects of various combinations of these grades and staples on spinnability, yarn skein strength, yarn appearance, and manufacturing waste were noted. In general, the deleterious effects of off-grade were offset by an increase in staple length of the low-grade type in spinning coarse-to-medium counts. It was indicated that a considerable economic advantage was obtainable through the strategic blending of various grades and staples of cotton over a range considerably wider than that generally considered practical in the industry.

Conclusions

1. The data presented in this report lead to the conclusion that in spinning coarse-to-medium counts of yarn it is feasible to blend cottons over wide ranges of grade and staple. However, it must be emphasized that:

This conclusion is valid only to the point that any two-bale blend can be depended upon to indicate the behavior of blends involving a large number of bales and/or samples of other varieties than those studied, when processed on all types of spinning equipment; and—perhaps much more important—only to the point that yarn strength, yarn appearance, and spinnability truly evaluate the raw cotton stock in terms of end-use factors, such as flex life, abrasion resistance, etc., of fabrics or yarns. A study of these latter properties must form an integral part of the program of any cotton mill which might be stimulated to study the possibilities inherent in blending.

2. When blending off-grade with better-grade cottons, the deleterious effects of the low-grade type can be compensated for by an increase in the staple length of this type. Thus, the greatest money value to be feasibly attained by blending, as indicated by the data obtained to date, lies in the production of coarse-to-medium counts of yarns, using blends of:

(*a*) Good grades of a short cotton with off-grades of a longer staple.

(*b*) Good grades of the longer staple with off-grades of a type progressively longer in staple than the short type that might be used in (*a*) above.

3. Without the use of preliminary spinning tests, blending techniques cannot be fully refined until more accurate methods of predicting processing behavior than now exist can be based on fiber-property measurements.

4. To set the machines properly to do full justice either to a blend or to the machines, it is necessary to depend upon some test method for quantitatively measuring the fiber length distribution in the given blend.

Summary of Results

1. For all blends and yarn counts studied, the decrease in yarn strength which occurred as the percentage of short staple in the blend was increased was not directly proportional to the amount of short cotton in the stock. Although this proportionality was evidenced in some cases, the data were sufficiently erratic to justify the conclusion noted above that preliminary spinning tests, such as those utilized in accumulating these data, are necessary if maximum advantage is to be taken of blending possibilities.

2. As the percentage of short cotton in a blend increased, it became increasingly difficult to spin the finer counts of yarn. This effect was exaggerated as the grade of the longer cotton was lowered.

3. As the grade of the longer cotton was lowered and the percentage of short cotton in the blend was

* A contribution of the Research Division, National Cotton Council of America, with laboratories on the campus of the University of Texas, in affiliation with the Bureau of Industrial Chemistry and the Texas Cotton Research Committee.

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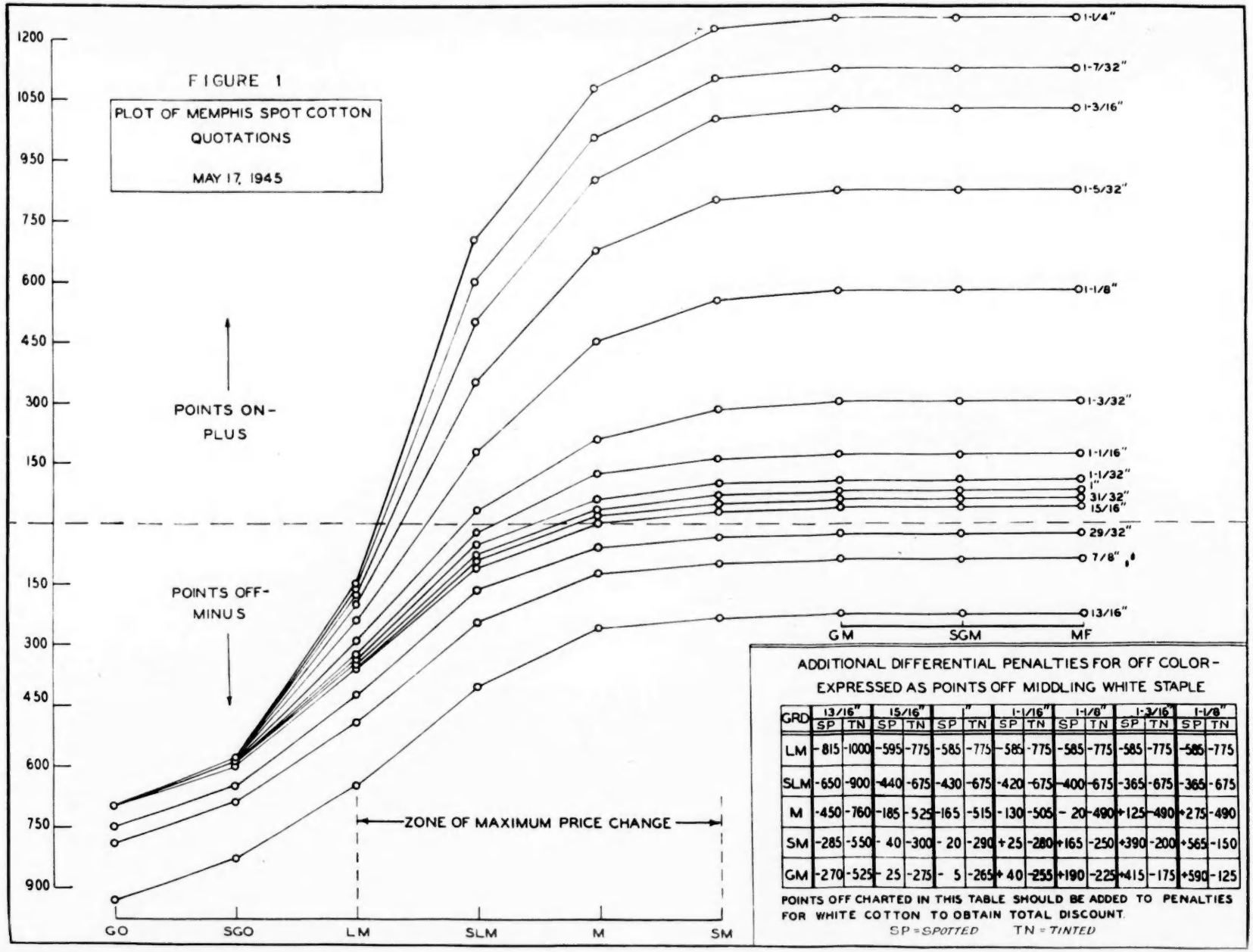
† Present address: Institute of Textile Technology, Charlottesville, Virginia.

FIGURE 1

PLOT OF MEMPHIS SPOT COTTON QUOTATIONS

MAY 17, 1945



ADDITIONAL DIFFERENTIAL PENALTIES FOR OFF COLOR - EXPRESSED AS POINTS OFF MIDDLING WHITE STAPLE

GRD	13/16"		15/16"		1"		1-1/16"		1-1/8"		1-3/16"		1-1/8"	
	SP	TN	SP	TN	SP	TN	SP	TN	SP	TN	SP	TN	SP	TN
LM	-815	-1000	-595	-775	-585	-775	-585	-775	-585	-775	-585	-775	-585	-775
SLM	-650	-900	-440	-675	-430	-675	-420	-675	-400	-675	-365	-675	-365	-675
M	-450	-760	-185	-525	-165	-515	-130	-505	- 20	-490	+125	-490	+275	-490
SM	-285	-550	- 40	-300	- 20	-290	+25	-280	+165	-250	+390	-200	+565	-150
GM	-270	-525	- 25	-275	- 5	-265	+ 40	-255	+190	-225	+415	-175	+590	-125

POINTS OFF CHARTED IN THIS TABLE SHOULD BE ADDED TO PENALTIES FOR WHITE COTTON TO OBTAIN TOTAL DISCOUNT.

SP = SPOTTED TN = TINTED

increased, the development of maximum strength depended more and more upon the use of that twist multiple selected as optimum for the short cotton, rather than the recommended twist multiple for the mean length of the upper half of the fibers, by weight, of the sample in question.

4. As the grade of the cottons blended was lowered, no significant change in yarn skein strength was evidenced that could not be attributed to variations in staple length.

5. Manufacturing waste data were accumulated which indicated that the increase in waste commonly associated with the use of off-grade cottons can be considerably reduced if carding practice is modified according to the dictates of the length of fibers being accumulated in the card strips, as measured with a Suter-Webb Sorter (and/or probably a Fibrograph).

6. There was little significant change in staple length evidenced as the cotton passed through the various processes.

7. The nep count of the blends tended to rise as the grade of either cotton was lowered, but the change was not striking.

Purpose of Research Project

The research reported in this paper was initiated in January, 1944, under the sponsorship of the Office of Production Research and Development, Industrial and Consumer Products Branch, War Production Board.

At the time of its initiation, the research had one basic objective, namely: *To assist the cotton mills in increasing production by permitting the use of cheaper, more abundant, off-grade, and off-staple cottons than were normally utilized.*

It may be recollected that during the early months of 1944, when the mills were being squeezed against price ceilings by the rising costs of both labor and cotton and the peculiar wartime demand for certain better grades and staples of cotton was causing a worrisome potential unbalance in the supply picture, the demands for increased cloth production by the Armed Forces and essential civilian uses were exceeding the output of the mills. It was hoped that some assistance in solving these complex production problems might be obtained by a study of blending cottons over wider ranges of grade and staple than normally would be attempted and by developing the necessary guides to proper processing techniques in handling these cottons.

The research was terminated on June 30, 1945. It was the decision of the several war agencies sponsoring the project that the work could no longer be considered of an emergency nature. Therefore the story presented here is far from complete. The scope of the project as originally outlined covered a much wider range of yarns, staple lengths, grades, and colors than was actually studied. However, the reception given to the several confidential reports distributed to the cotton spinners during the course of this study has been such as to make it advisable to publish all of the accumulated data, for general use.

To facilitate a better understanding of some of the reasoning behind the methodology used in this study, Figure 1 was prepared to illustrate a perennial situation in cotton marketing.

An analysis of Figure 1 reveals, for example, that:

1. In all staple lengths, little significance is attached to any differences between grades SM and better. Therefore, if there are real differences in these grades, the benefits of using the presumably cleaner cottons should be of interest to any mill. It is true that supplies in the better grades are not too abundant, but some cotton in these grades can be obtained. Their use in blends may be highly desirable.

2. As the grade improves to SM, the premium for additional staple length markedly increases.

3. As the grade lowers from SM, the presence of the trash (and perhaps poor preparation) becomes more important, in terms of price, than staple length.

4. For the longer staples, the price decreases much more rapidly with decreases in grade than for the shorter cottons.

5. The savings made possible by changing grade within white cottons are greatly magnified if the color is also varied from white to spotted to tinged.

Concerning these points, the question arises: Would it be possible, by means of better cleaning or of blending clean and trashy cottons, or both, etc., to realize a saving in cost by using off-grade cottons, without a significant lowering of quality and output?

Obviously, a price structure such as that pictured in Figure 1 could have its basis only in the traditional concept of the value of various types of cotton to the mills, taken together with current forces of supply and demand. However, the perennial stability of the form of this price structure—despite advances in cleaning and spinning practices; despite the steady increase in the number of cotton end-uses

and concomitant changes in the complexity of the specific requirements of a fabric; despite the improvement in laboratory measurements of the properties of raw cotton, yarn, and fabric—seems to justify questioning the validity of the unchanging nature of cotton marketing practices.

The philosophical and technical stimulation for the research reported in this paper was an awareness of the data revealed in Figure 1.

Experimental Methods

Raw Material. The longer cotton, in all grades studied, was Bobshaw No. 1, obtained from the Bobshaw Chemurgic Plantation, Heathman, Mississippi, out of the 1943–1944 crop.

The short cotton, in all grades studied, was Hi-Bred, grown at Lamesa, Texas, during the 1943–1944 season.

Ten-pound picker laps were used in all spinning tests.

Fiber Testing. Fiber tests were made at standard atmospheric conditions (65 percent relative humidity and 70°F). The tests made included the Pressley Index, fineness (micrograms per inch), and Suter-Webb Length Analysis. No specific use was made of these data.

Yarn Testing. All yarn was tested and graded by A.S.T.M. (D 180–42) recommended practice.

Manufacturing Setup

1. *Opening:* Cotton mixed and fed by hand to an adapted Bramwell Feed, which supplied a Superior Cleaner.
2. *Picking:* Two-beater, rebuilt Aldrich synchronized one-process picker:
   (*a*) First beater (Aldrich)—1,173 r.p.m.
   (*b*) Second beater (Kirschner)—987 r.p.m.
   (*c*) 15-oz. lap produced.
3. *Carding:* Whitin 40-in. card.
   Speeds:
   (*a*) Lickerin—420 r.p.m.
   (*b*) Cylinder—169 r.p.m.
   (*c*) Doffer—6.75 r.p.m. for 100% Bobshaw; 8.00 r.p.m. for blends; 9.00 r.p.m. for 100% Hi-Bred.
   (*d*) Flats—4.5 in./min.
   Settings:
   (*a*) Feed plate to lickerin—0.009 in.
   (*b*) Flats to cylinder—0.011 in.
   (*c*) Doffer to cylinder—0.007 in.
   (*d*) Other settings standard.
   Weight: 45-grain sliver produced.
4. *Drawing:* Whitin—common rolls.
   (*a*) For 100%, $^{13}/_{16}$-in. staple, center-to-center settings of the rolls from front to back were $1^{3}/_{16}$, $1^{5}/_{16}$, and $1^{7}/_{16}$ in.
   (*b*) For all other tests, these spacings, in the same order, were $1^{1}/_{4}$, $1^{3}/_{8}$, and $1^{1}/_{2}$ in.
5. *Roving:* Whitin Super-Draft.
   2.50 hank roving made with a draft of 13.50; 1.20 twist multiple.
6. *Spinning:* Whitin Long-Draft.
   (*a*) 11s spun from 2.50 hank roving; 8.80 draft; double-creeled.
   (*b*) 22s spun from 2.50 hank roving; 17.60 draft; double-creeled.
   (*c*) 33s spun from 2.50 hank roving; 26.40 draft; double-creeled.

Twist Selections

Four twist multiples were used in each spinning test. The selection in each case was based on the mean length of the upper-half by weight of the fibers in a Suter-Webb array of either the pure Bobshaw, the pure Hi-Bred, or a weight-percent blend.

Three of the multiples were calculated from the Brandt nomograph [1]. The fourth, noted as "U.S. D.A." on the graphs and tables, was that recommended by the United States Department of Agriculture [2].

The selection of the U.S.D.A. twist multiple was based on the array of the particular blend involved.

For each series of blends involving two specific grades, the three Brandt twist multiples used were the same in all spinning tests and were based on the upper-half mean length of the pure Bobshaw, the pure Hi-Bred, and the 50-50 mix. The same three twists were also used in spinning the pure variety.

Experimental Results and Discussion

I. Data in Figures 2, 3, and 4, and Table I

Figures 2, 3, and 4 and Table I depict the yarn skein strength data for the 29 blends covered in this report. Sufficient statistical data were obtained on

FIGURE 2

EFFECT OF VARYING BLEND COMPOSITION AND TWIST MULTIPLIER WITHIN A BLEND ON CORRECTED SKEIN STRENGTH

11'S YARN

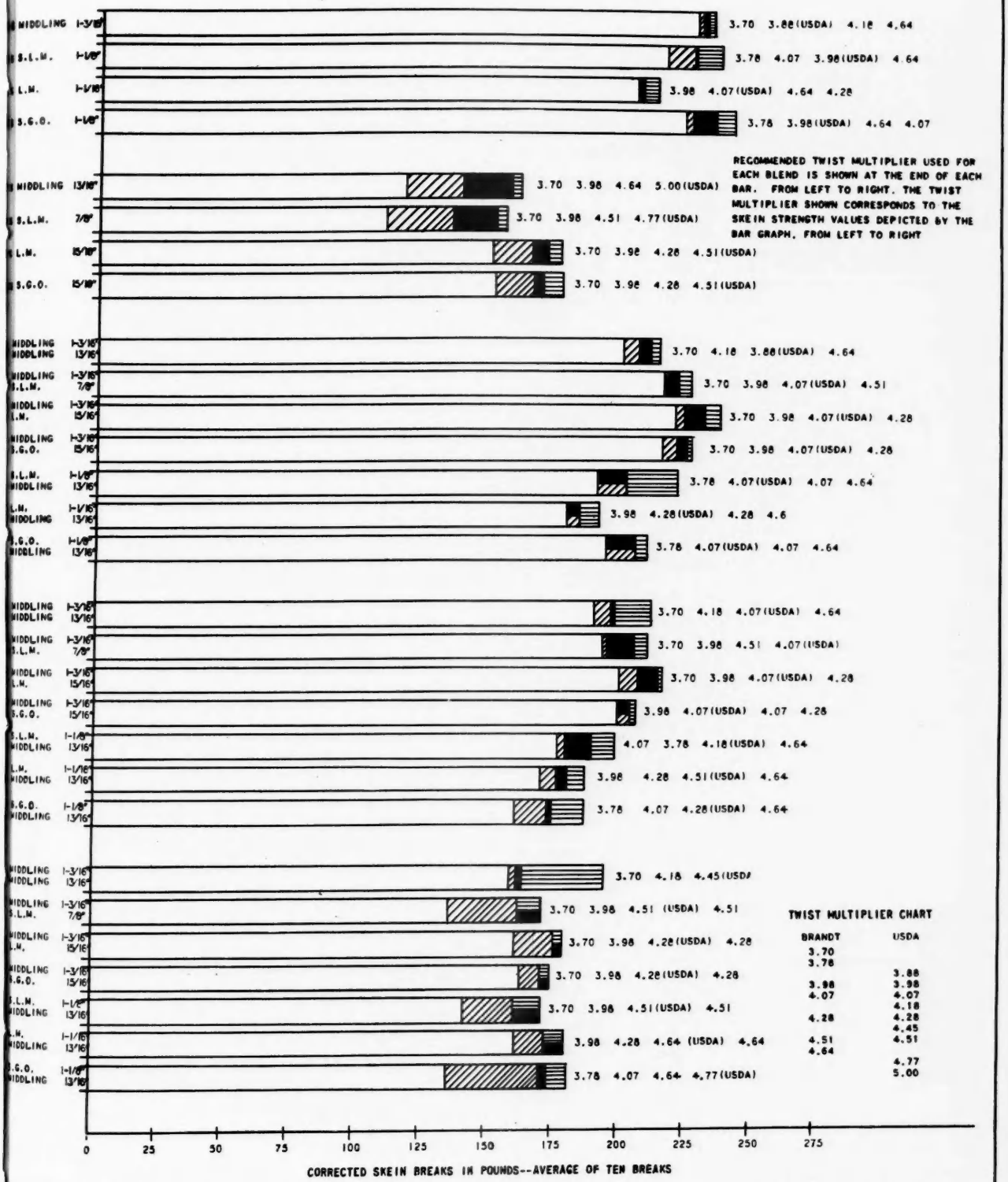


FIGURE 3

EFFECT OF VARYING BLEND COMPOSITION AND TWIST MULTIPLIER WITHIN A BLEND ON CORRECTED SKEIN STRENGTH

22'S YARN

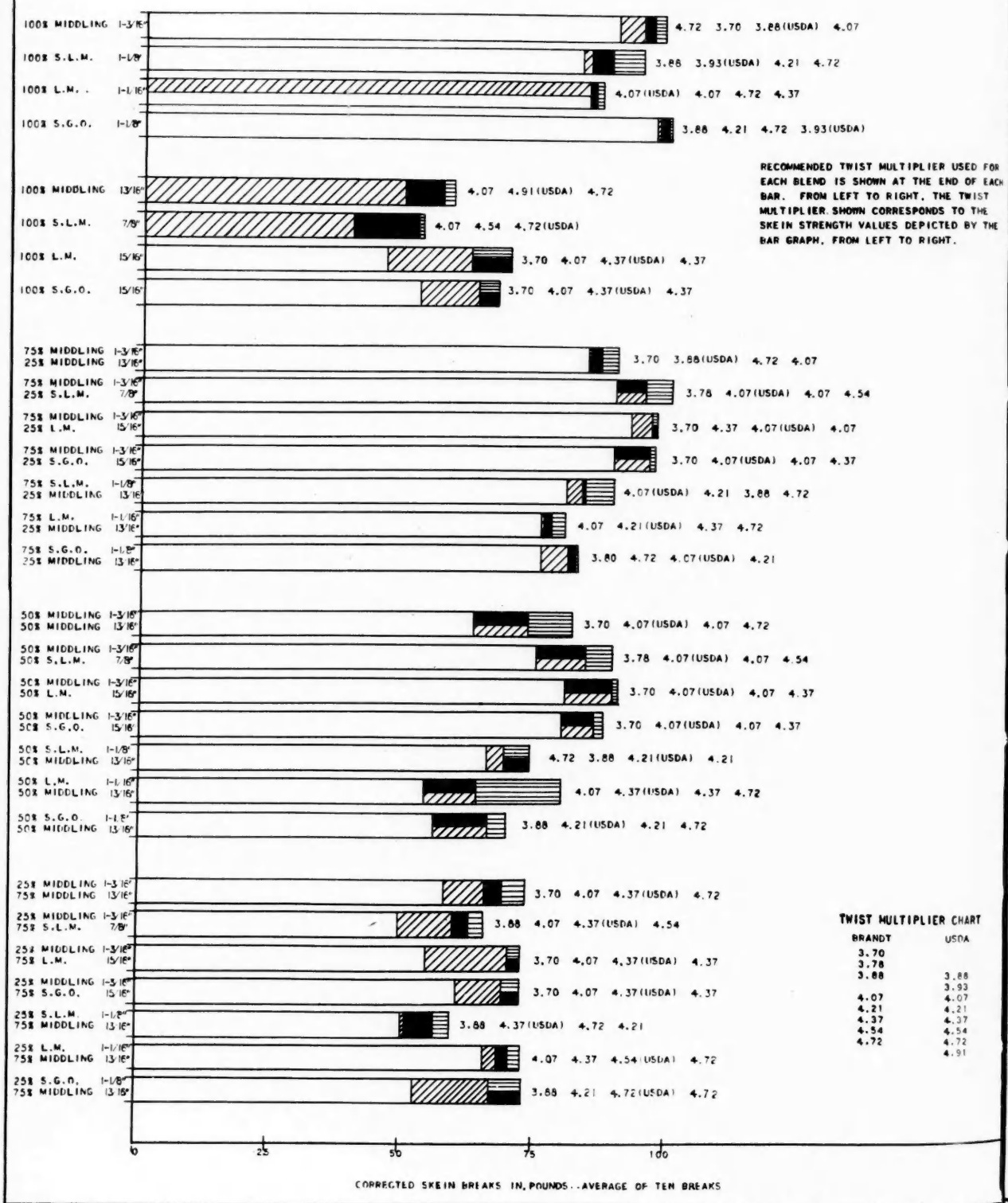


FIGURE 4

EFFECT OF VARYING BLEND COMPOSITON AND TWIST MULTIPLIER WITHIN A BLEND ON CORRECTED SKEIN STRENGTH

33'S YARN

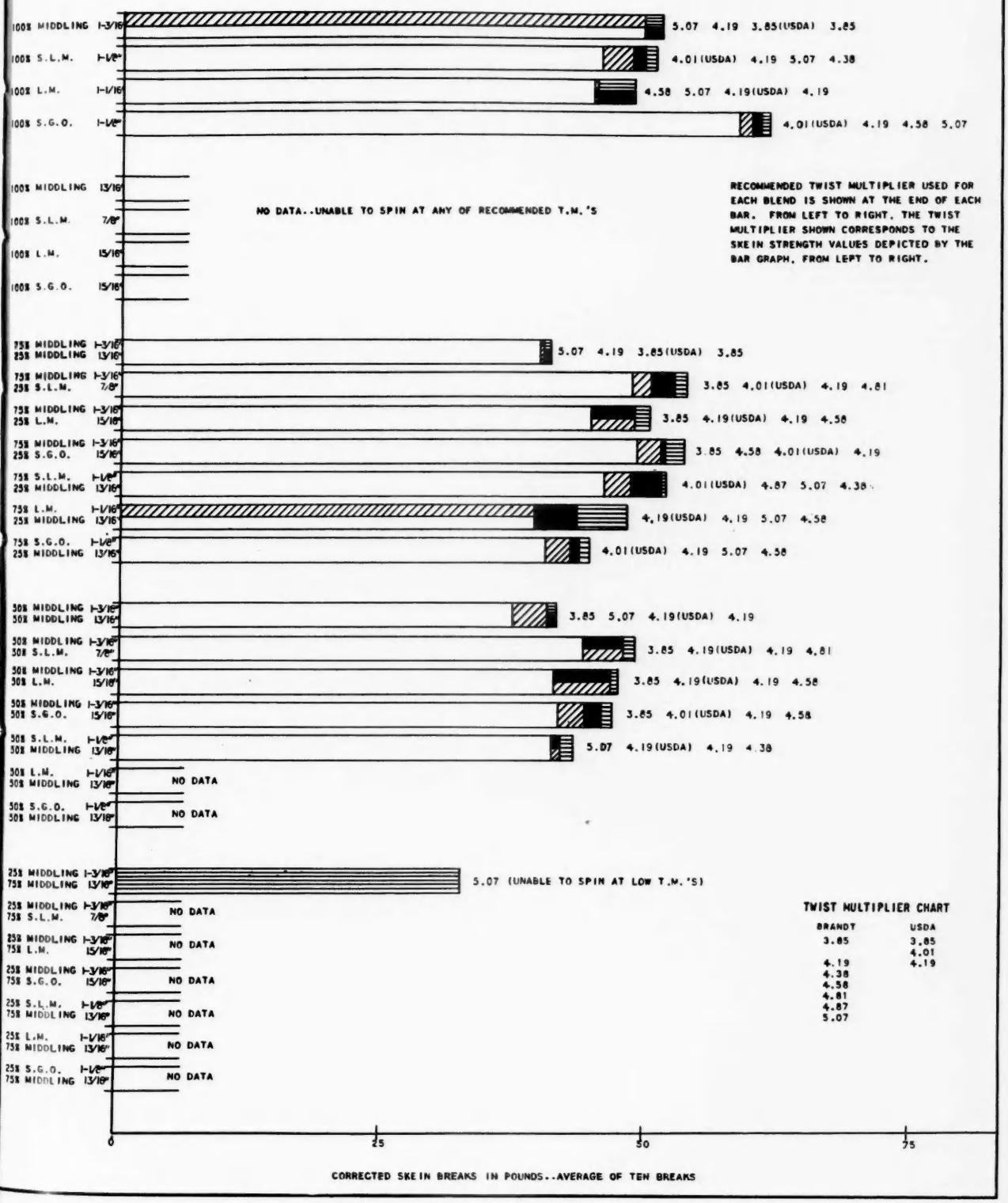

100% MIDDLING 1-3/16" 5.07 4.19 3.85(USDA) 3.85
100% S.L.M. 1-1/8" 4.01(USDA) 4.19 5.07 4.38
100% L.M. 1-1/16" 4.58 5.07 4.19(USDA) 4.19
100% S.G.O. 1-1/8" 4.01(USDA) 4.19 4.58 5.07
100% MIDDLING 13/16"
100% S.L.M. 7/8"
100% L.M. 15/16"
100% S.G.O. 15/16"
NO DATA..UNABLE TO SPIN AT ANY OF RECOMMENDED T.M.'S
RECOMMENDED TWIST MULTIPLIER USED FOR EACH BLEND IS SHOWN AT THE END OF EACH BAR. FROM LEFT TO RIGHT, THE TWIST MULTIPLIER SHOWN CORRESPONDS TO THE SKEIN STRENGTH VALUES DEPICTED BY THE BAR GRAPH, FROM LEFT TO RIGHT.
75% MIDDLING 1-3/16" 25% MIDDLING 13/16" 5.07 4.19 3.85(USDA) 3.85
75% MIDDLING 1-3/16" 25% S.L.M. 7/8" 3.85 4.01(USDA) 4.19 4.81
75% MIDDLING 1-3/16" 25% L.M. 15/16" 3.85 4.19(USDA) 4.19 4.58
75% MIDDLING 1-3/16" 25% S.G.O. 15/16" 3.85 4.58 4.01(USDA) 4.19
75% S.L.M. 1-1/8" 25% MIDDLING 13/16" 4.01(USDA) 4.87 5.07 4.38
75% L.M. 1-1/16" 25% MIDDLING 13/16" 4.19(USDA) 4.19 5.07 4.58
75% S.G.O. 1-1/8" 25% MIDDLING 13/16" 4.01(USDA) 4.19 5.07 4.58
50% MIDDLING 1-3/16" 50% MIDDLING 13/16" 3.85 5.07 4.19(USDA) 4.19
50% MIDDLING 1-3/16" 50% S.L.M. 7/8" 3.85 4.19(USDA) 4.19 4.81
50% MIDDLING 1-3/16" 50% L.M. 15/16" 3.85 4.19(USDA) 4.19 4.58
50% MIDDLING 1-3/16" 50% S.G.O. 15/16" 3.85 4.01(USDA) 4.19 4.58
50% S.L.M. 1-1/8" 50% MIDDLING 13/16" 5.07 4.19(USDA) 4.19 4.38
50% L.M. 1-1/16" 50% MIDDLING 13/16" NO DATA
50% S.G.O. 1-1/8" 50% MIDDLING 13/16" NO DATA
25% MIDDLING 1-3/16" 75% MIDDLING 13/16" 5.07 (UNABLE TO SPIN AT LOW T.M.'S)
25% MIDDLING 1-3/16" 75% S.L.M. 7/8" NO DATA
25% MIDDLING 1-3/16" 75% L.M. 15/16" NO DATA
25% MIDDLING 1-3/16" 75% S.G.O. 15/16" NO DATA
25% S.L.M. 1-1/8" 75% MIDDLING 13/16" NO DATA
25% L.M. 1-1/16" 75% MIDDLING 13/16" NO DATA
25% S.G.O. 1-1/8" 75% MIDDLING 13/16" NO DATA
TWIST MULTIPLIER CHART
BRANDT USDA
3.85 3.85
4.01
4.19 4.19
4.38
4.58
4.81
4.87
5.07
0
25
50
75
CORRECTED SKEIN BREAKS IN POUNDS..AVERAGE OF TEN BREAKS

TABLE I. EXPERIMENTAL DATA—CORRECTED SKEIN STRENGTH WITH STANDARD DEVIATION AND A.S.T.M. YARN GRADES (AVERAGE OF 10 TESTS—11s YARN)

100% Bobshaw No. 1

	T.M.	Midd. 1 3/16"			S.L. Midd. 1 1/8"			L. Midd. 1 1/16"			S.G.O. 1 1/8"		
		GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD
B	3.70	A−	227.0	6.6									
B	3.78				A−	214.5	11.4				A−	222.5	9.0
A	3.88	A−	229.7	8.1									
AB	3.98	B+	230.2	18.6	B+	226.4	6.0	A−	204.5	5.4	A−	226.6	6.0
AB	4.07				A−	226.3	5.1	A−	205.2	5.7	B+	239.8	8.1
B	4.28							A−	211.8	8.1			
B	4.64	A−	233.1	7.2	A−	234.5	5.4	A−	207.4	4.8	B+	233.6	7.8

100% Hi-Bred

	T.M.	Midd. 13/16"			S.L. Midd. 7/8"			L. Midd. 13/16"			S.G.O. 13/16"		
		GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD
B	3.70	B	116.1	7.5	A−	108.3	12.0	A−	149.5	3.9	A−	150.9	9.3
B	3.98	B	137.9	7.5	B+	134.4	11.7	A−	164.5	2.1	B+	165.0	3.9
B	4.28							A−	171.2	5.4	A−	168.6	8.1
AB	4.51				B+	151.5	6.9	A−	175.0	4.2	A−	176.1	6.6
B	4.64	B	156.5	5.4									
A	4.77				A−	154.1	6.3						
A	5.00	A−	159.3	9.9									

75% Bobshaw No. 1 and 25% Hi-Bred

	T.M.	Bob. Midd. 1 3/16" Hib. Midd. 15/16"			Bob. Midd. 1 3/16" Hib. S.L.M. 7/8"			Bob. Midd. 1 3/16" Hib. L.M. 13/16"			Bob. Midd. 1 3/16" Hib. S.G.O. 15/16"			Bob. S.L.M. 1 1/8" Hib. Midd. 13/16"			Bob. L.M. 1 1/16" Hib. Midd. 13/16"			Bob. S.G.O. 1 1/8" Hib. Midd. 13/16"		
		GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD	GRD	C.S.S.	SD
B	3.70	B+	199.9	9.0	A−	215.7	6.3	A−	219.4	5.7	A−	214.4	6.6									
B	3.78													A−	190.1	7.2				B+	193.7	9.9
A	3.88	B+	209.4	6.9																		
B	3.98	B+	205.6	9.9	A−	216.4	5.7	A−	222.6	7.8	A−	220.6	10.2				A−	178.3	7.8			
AB	4.07				A−	221.5	4.8	A−	230.1	6.6	A−	224.6	7.8	A−	201.1	7.5				B+	205.6	5.7
AB	4.28							A−	235.2	5.1	A−	226.9	4.2				A−	183.6	7.5			
B	4.51				A−	225.9	7.8															
B	4.64	A−	213.4	10.2										A−	220.6	5.1	A−	191.1	6.3	B+	208.3	8.4

50% Bobshaw No. 1 and 50% Hi-Bred

B	3.70	B+	188.5	7.2	A−	193.9	5.7	A−	199.7	3.9	A−	192.5	6.0									
B	3.78													A−	179.3	7.2				A−	159.7	5.4
B	3.98	B+	195.4	6.3	A−	194.6	6.3	A−	207.0	7.5	A−	198.1	10.8				A−	169.4	7.8			
AB	4.07	A−	197.9	6.6	A−	208.4	5.4	A−	213.9	4.8	A−	203.0	4.8	A−	176.8	9.9				B+	172.5	6.9
A	4.17													B+	188.3	6.9						
AB	4.28							A−	214.1	7.8	A−	206.1	9.9				A−	176.6	7.5	B+	174.7	9.0
AB	4.51				A−	204.1	6.3										A−	180.0	3.6			
B	4.64	B+	211.2	5.4										A−	197.6	6.3	A−	186.0	9.3	A−	185.3	7.5

25% Bobshaw No. 1 and 75% Hi-Bred

B	3.70	B+	157.9	7.8	B+	142.2	6.3	A−	162.2	6.6	A−	162.7	7.5									
B	3.78													B+	143.6	6.6				B	135.6	7.8
B	3.98	B	161.8	4.8	A−	161.2	2.1	A−	175.8	2.1	A−	171.7	6.6				A−	161.5	8.4			
B	4.07													B+	156.2	6.3						
AB	4.28							B+	178.2	6.6	A−	174.2	10.2							A−	166.9	9.6
A	4.39													B+	161.1	4.8	A−	172.5	4.8			
A	4.45	B+	162.8	7.8																		
AB	4.51				A−	170.6	5.1															
AB	4.64													B	170.8	4.2	A−	179.2	7.5	A−	168.4	9.3
A	4.77																			A−	181.8	7.8

A—These twist multipliers are recommended by the U. S. D. A. for obtaining maximum skein strength based on the staple length (upper half mean by weight) of the cotton as determined in the Suter-Webb Sorter. The staple used is the length determined from the blend (picker lap sample).

B—These twist multipliers are based on Brandt's nomograph for maximum skein strength (*Textile World*, December, 1934) using the staple of the 100% Bobshaw, 100% Hi-Bred, and the 50%–50% blend.

TABLE II. FIBER DATA, CARD WASTE DATA, AND NEP COUNT OF BLENDS

	Data	100% Bobshaw No. 1 Midd. 1 3/16"	S.L. Midd. 1 1/8"	L. Midd. 1 1/16"	S.G.O. 1 1/8"	100% Hi-Bred Midd. 13/16"	S.L. Midd. 7/8"	L. Midd. 15/16"	S.G.O. 15/16"
A	Fiber								
	Fineness microgr./in.	5.15	4.94	5.44	4.35	5.43	5.50	6.76	5.74
B	Pressley Index	7.84	8.20	7.81	7.82	7.81	7.16	7.21	6.79
C	Waste percentage								
	Card strips	2.66	2.36	2.86	2.70	2.89	2.47	2.43	3.13
	Card motes	1.34	1.35	1.96	1.52	2.12	1.97	2.43	3.65
	Card fly	0.17	0.17	0.36	0.34	0.38	0.33	0.52	0.52
	C. & D. strips	0.17	0.34	0.36	0.34	0.39	0.33	0.17	0.35
	Total waste	4.34	4.22	5.54	4.90	5.78	5.10	5.55	7.65
	Nep count per sq. in. card web	0.189	0.146	0.146	0.286	0.205	0.168	0.168	0.378

75% Bobshaw No. 1 and 25% Hi-Bred

	Data	Bob. Midd. 1 3/16" Hib. Midd. 13/16"	Bob. Midd. 1 3/16" Hib. S.L.M. 7/8"	Bob. Midd. 1 3/16" Hib. L.M. 15/16"	Bob. Midd. 1 3/16" Hib. S.G.O. 15/16"	Bob. S.L.M. 1 1/8" Hib. Midd. 13/16"	Bob. L.M. 1 1/16" Hib. Midd. 13/16"	Bob. S.G.O. 1 1/8" Hib. Midd. 13/16"
C	Waste percentage							
	Card strips	2.20	2.70	2.20	2.70	2.33	2.70	2.33
	Card motes	1.18	1.35	0.84	1.52	1.50	1.52	1.17
	Card fly	0.17	0.34	0.17	0.34	0.33	0.34	0.33
	C. & D strips	0.34	0.34	0.17	0.17	0.33	0.17	0.17
	Total waste	3.89	4.73	3.38	4.73	4.49	4.73	4.00
	Nep count per sq. in. card web	0.254	0.146	0.232	0.108	0.173	0.184	0.324

50% Bobshaw No. 1 and 50% Hi-Bred

C	Waste percentage							
	Card strips	2.70	3.29	2.43	2.70	2.67	2.95	2.63
	Card motes	1.52	1.64	1.56	2.03	1.67	1.79	1.64
	Card fly	0.34	0.33	0.35	0.34	0.17	0.36	0.66
	C. & D. strips	0.34	0.49	0.17	0.34	0.33	0.36	0.33
	Total waste	4.90	5.75	4.51	5.41	4.84	5.46	5.26
	Nep count per sq. in. card web	0.254	0.200	0.168	0.281	0.195	0.216	0.211

25% Bobshaw No. 1 and 75% Hi-Bred

C	Waste percentage							
	Card strips	2.67	2.95	2.70	3.25	2.83	3.04	2.30
	Card motes	1.67	2.26	2.03	2.74	1.83	1.86	1.48
	Card fly	0.33	0.35	0.34	0.34	0.33	0.34	0.33
	C. & D. strips	0.33	0.35	0.34	0.34	0.33	0.34	0.33
	Total waste	5.00	5.91	5.41	6.67	5.32	5.58	4.44
	Nep count per sq. in. card web	0.254	0.151	0.216	0.254	0.227	0.184	0.259

A—All fiber tests refer to picker lap. B—Pressley tests are an average of 20 breaks made on two machines by two operators.
C—Waste percentage is based on a 10-pound picker lap. This explains the unusually high waste factor.

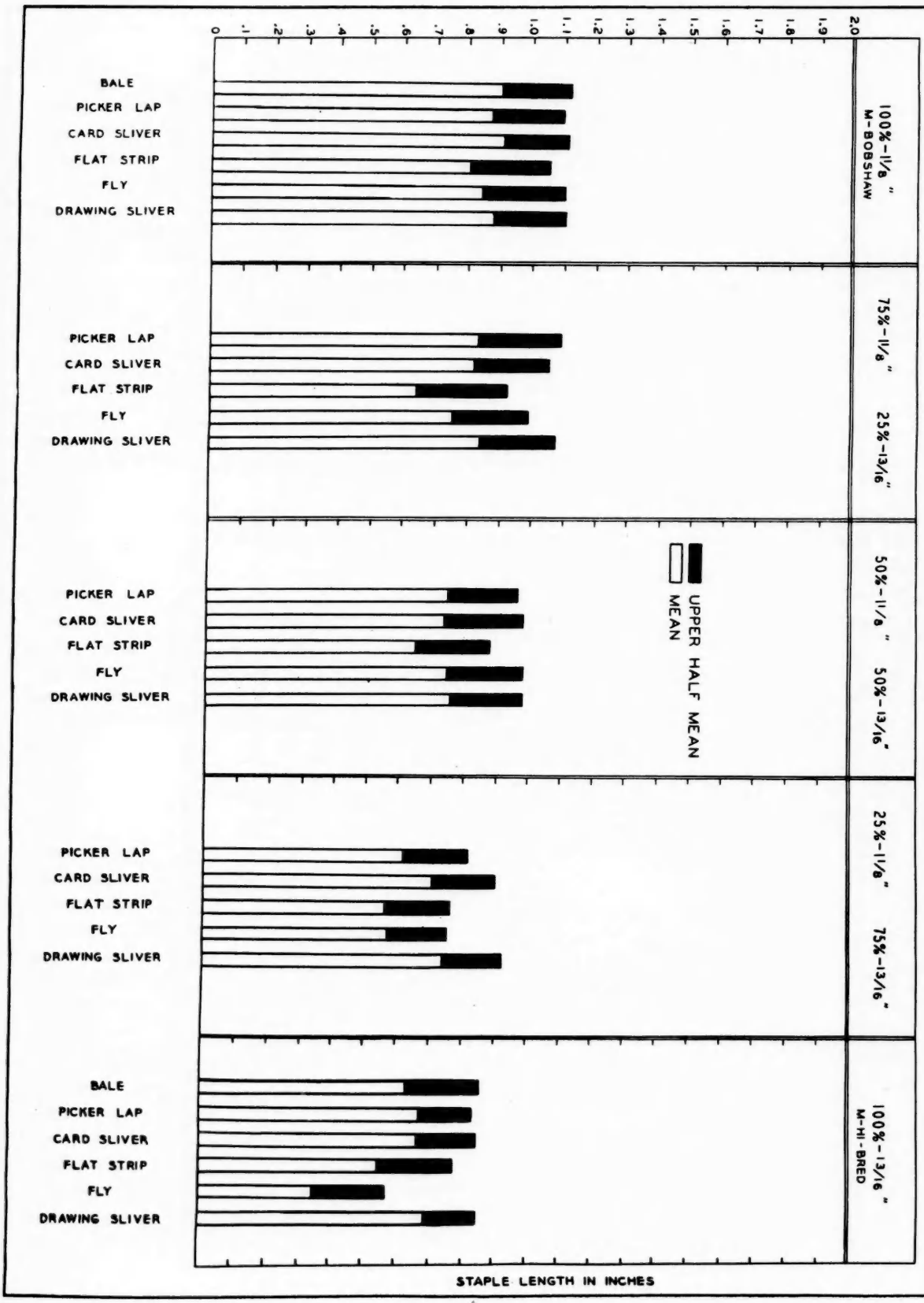


FIGURE 5

EFFECT OF THE VARIOUS SPINNING PROCESSES ON STAPLE LENGTH OF THE VARIOUS BLENDS AS MEASURED WITH A SUTER-WEBB MECHANICAL SORTER BLEND II

FIGURE 6

EFFECT OF THE VARIOUS SPINNING PROCESSES ON STAPLE LENGTH OF THE VARIOUS BLENDS AS MEASURED WITH A SUTER-WEBB MECHANICAL SORTER BLEND V

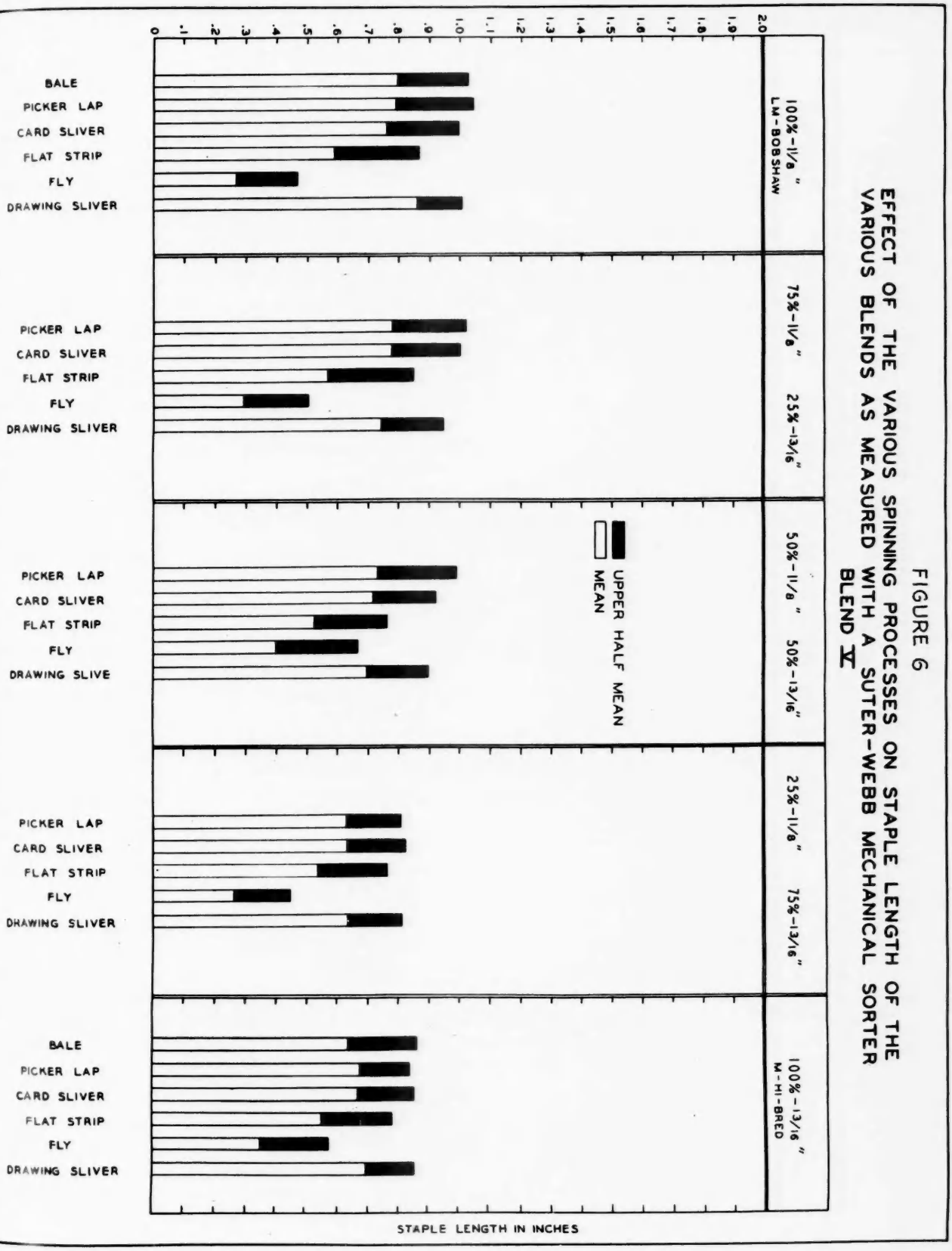

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
100% - 1 1/8 " LM-BOB SHAW
75% - 1 1/8 " 25% - 13/16 "
50% - 1 1/8 " 50% - 13/16 "
25% - 1 1/8 " 75% - 13/16 "
100% - 13/16 " M-HI-BRED
BALE
PICKER LAP
CARD SLIVER
FLAT STRIP
FLY
DRAWING SLIVER
UPPER HALF MEAN
MEAN
STAPLE LENGTH IN INCHES

FIGURE 5

EFFECT OF THE VARIOUS SPINNING PROCESSES ON STAPLE LENGTH OF THE

the average skein strength values to delimit their eccentricity and to determine the significant differences. These data were so voluminous that in the interest of space conservation only those relating to 11s yarns are included (Table I) as a demonstration of the influence of blend composition on yarn variability. The data for the finer yarns are available on request; they follow the same trends as those noted in Table I.

Analysis of the data indicated:

1. In those cases in which statistically significant differences between skein strengths are demonstrated, the influence of staple length rather than grade seems to be the dominating factor.*

Thus, it was first noted that for the unblended cottons, in the case of both the Hi-Bred and Bobshaw varieties, the poorest grades of cotton yielded the strongest yarns. The S.G.O. bales, in both cases, demonstrated the longest weighted upper-half mean staple length.

To emphasize this point, the following method of analysis was utilized, taking by way of illustration the low-middling and middling bales of Bobshaw:

$$(a) \qquad \frac{m_2 - m_1}{\sigma d} = 6.1,$$

indicating that the mean strength differences were actually due to a fundamental difference in the populations.

(*b*) If, in each case, the maximum yarn strength was divided by the upper-half mean length in thirty-seconds of an inch, a factor was obtained which, it might be argued, represented the effective contribution of staple length, irrespective of other factors. Thus:

(1) Skein strength of 100% L.M. Bobshaw = 212
Number of 1/32-in. length = 34
K = 6.24

(2) Skein strength of 100% M. Bobshaw = 233
Number of 1/32-in. length = 38
K = 6.13

Similar calculations covering all of the blends studied did not, in every case, develop such perfect evidence for the importance of staple length when contrasted with grade, but the trend was sufficiently positive to justify the conclusion noted above. These data are in accord with those presented by Webb and Richardson in their much more exhaustive study of the relationships between fiber properties and yarn strengths [3].

2. As the percentage of short cotton in the blend increased, yarn strength tended to decrease, but with no constancy or regularity.

The eccentricities noted merely emphasized the complexity of the problem of predicting the behavior of cotton fibers during processing and indicated the necessity for experimental spinning trials if blending techniques are to be successfully employed.

At this point, it is well to indicate the potential savings indicated by the data variously shown in Figures 2–4 and Table I. For example, using the blend of middling Bobshaw $1\frac{3}{16}$-inch with the low-middling Hi-Bred $1\frac{15}{16}$-inch, the skein strength and cost data for three blends are:

Blend	11s yarn skein strength (lbs.)	Cost of cotton*	Savings per 500-lb. bale
100% $1\frac{3}{16}$ in.	233	+650.0	—
75% $1\frac{3}{16}$ in. 25% $\frac{15}{16}$ in.	235	+387.5	$13.13
50% $1\frac{3}{16}$ in. 50% $\frac{15}{16}$ in.	214	+125.0	$26.25

It is true that this may be an exaggerated case which greatly overemphasizes yarn strength to the exclusion of many other important properties. Yet it cannot be gainsaid that in many instances skein strength values dominate the thinking of mill men.

* From Figure 1.

* Only the simplest statistical techniques are required to evaluate significance with reasonable accuracy. The following procedure was followed in this study:

(*a*) The standard error for each mean strength value was first calculated from the formula:

$$\sigma m = \text{Standard error} = \frac{\text{Standard deviation}}{\sqrt{\text{Number of skeins tested}}}.$$

(*b*) The standard error of the difference between any two mean strength values was then calculated from the formula:

$$\sigma d = \sqrt{(\sigma m_1)^2 + (\sigma m_2)^2}.$$

(*c*) Assuming that a 95 percent probability (odds of 19 : 1) of a significant difference was sufficient, then if

$$\frac{m_2 - m_1}{\sigma d} \geqq 2,$$

where m_2 and m_1 are mean strength values, then these mean values differ significantly from one another.

(*d*) For greater refinement, experience has shown that if

$$m_2 - m_1 \geqq 3\sigma d,$$

the chances are better than 99 : 1 that the difference is significant.

and if there is any validity in the use of skein strength data the potential savings in the use of strategic blendings, conceived on the basis of experimental data, should certainly be stimulating to the imagination.

3. No increase in yarn irregularity, as gaged by skein strength data, was attributable either to grade or to variations in blend percentages.

4. No qualitative degradation in yarn appearance was observed as a result of variations in the character of the blend. Since this was somewhat surprising, it may be a commentary on the nature of the test.

5. In spinning 33s, the influence of the poorer grades of cotton, particularly of the longer cotton, in impeding spinning, was marked.

This observation further emphasizes the fact that the data on the blends studied in this project lead to the conclusion that, as the yarn number of the cotton to be spun decreases, increasing advantage can be taken of blending cottons over progressively wider ranges of grade and staple.

6. The relationships of yarn twist to skein strength do not deviate unexpectedly from those predicted on the basis of the known experiences in the industry.

There is some indication that in those blends containing 25 percent of the longer cotton, the twist necessary for maximum strength remains the one which is recommended for the shorter cotton alone.

II. Data in Table II

Table II summarizes the data obtained on fiber, waste, and nep count. The following comments may be made on the material in Table II:

1. No use has been made of the fiber data for interpreting the results of the spinning tests. The fiber data were included for the use of those agencies which are capable of more comprehensive evaluation of fiber properties in terms of spinnability than could be attempted during this study.

2. The waste data are interesting mainly because the waste evidenced by the blends closely approximated the waste to be expected, on the basis of the amount of each cotton blended and the waste demonstrated by these cottons when tested separately.

During the course of this study, a number of blends were made, which are not covered in this report, during which it was clearly demonstrated that unless the machines were carefully set to handle the staple of cotton determined from the Suter-Webb arrays, excessive waste would result. This concept is not new to the industry, and it is well known that the waste removed at various stages of manufacture differs widely in different mills. Emphasis is placed on the point merely to indicate a mechanism permitting a closer control over waste, and the development of a greater flexibility in the use of blends.

For example, two blends were studied involving middling Hi-Bred and low-middling Bobshaw (Blend V, Figure 6), and middling Hi-Bred and middling Bobshaw (Blend II, Figure 5). In the carding of Blend II, the settings on the card resulted in 40 to 50 percent more card waste than was evidenced in carding Blend V. In addition to the removal of more waste, the quality of the waste was much higher for Blend II, as may be noted from Figures 5 and 6.

3. Nep count tended to increase as the grade of cotton was lowered, but the blends evidenced the nep count which was, roughly, to be expected, on the basis of the grades and amounts of cotton blended.

4. Since the number of spindles used per test was small (only 15), and the amount of cotton blended was only 10 pounds, the number of ends down per thousand spindle hours (the common method of reporting such data) was not recorded. In laboratory practice, a blend was considered unspinnable when it was impossible to keep as many as 10 ends going during the time of the spinning test.

III. Data in Figures 5 and 6

Figures 5 and 6 also indicate the effect of the manufacturing processes on staple length, which seems to be negligible as measured on the Suter-Webb Sorter. As with waste and nep count, individual mill practice so markedly affects such measurements that no further comment will be made.*

Literature Cited

1. Brandt, Carl D. Cotton Twists. *Textile World* **88**, 247 (Feb., 1934); **88**, 1055 (May, 1934); **88**, 2405–6 (Dec., 1934).
2. U. S. Department of Agriculture, War Food Administration, Office of Distribution. "Cotton Fiber and Spinning Testing Service," Sept., 1944.
3. Webb, R. W., and Richardson, H. B. "Relationships Between Properties of Cotton Fibers and Strength of Carded Yarn," U. S. Department of Agriculture, War Food Administration, Office of Marketing Service, Mar., 1945.

* ACKNOWLEDGMENT: The steady and ingenious assistance of Mr. Jimmy Little during the course of this study is fully and gratefully acknowledged. Without his constant care and understanding of the problem during the spinning and testing of the various blends, this report would not have been completed.

Selected References Relating to the Field of Color Science

Dorothy Nickerson*

This specialized bibliography is the second in a series which is planned for publication in TEXTILE RESEARCH JOURNAL. *The first, which appeared in the October, 1945, issue, was entitled "Selected References on Surface Chemistry and Physics." Each bibliography in the series is intended to present a list of books and other primary references in a restricted field, which will serve as a basis for the accumulation of a company or a personal library.*

IN order to supply titles for a shelf of reference material that will serve to keep the textile man reasonably up to date with modern work in the field of color science and its application, the following list has been prepared under several headings: General References (1–14); Color Standards and Color Charts (15–24); Color Tests (25–29); The Eye (30–32); Periodical Literature, covering recent work unavailable in book form (33–39).

On a technical worker's book shelf there would also be books on optics, physiological optics, photometry, radiation, and mathematics, but it has not seemed necessary to include material on these subjects in this list. References connected with dyes, dyeing, and the chemistry and constitution of color will be covered in separate lists to appear later.

The list of books given here is intended to cover those which are currently important in the science of color. It does not pretend to cover those that have been written for the layman; a few of these are listed but others might equally well have been included.

General References

1. Birren, Faber. 1941. *The Story of Color.* 338 pp., illus. Crimson Press (Westport, Conn.).

This is one of a dozen or more books written by Mr. Birren for the layman. While they have provoked considerable discussion and criticism, Mr. Birren's books make a sincere attempt to present the subject of color to the layman in a way that will both interest and inform him. Technical workers would do well to include some of his books in their libraries. This particular book has been selected because it includes an extensive general bibliography.

2. Boring, E. G. 1942. *Sensation and Perception in the History of Experimental Psychology.* xv + 644 pp., illus. Appleton-Century (New York).

A readable and sound summary which brings this history up to about 1930. The book is a sequel to *A History of Experimental Psychology.* It contains 6 chapters on vision, 3 on audition, one each on smell and taste, touch, organic sensibility, and the perception of time and movement.

3. Burris-Meyer, Elizabeth. 1938. *Historical Color Guide.* 30 pp., illus. (30 plates). Wm. Helburn Inc. (New York).

This book is one of four by Mrs. Burris-Meyer that concern the application of color to clothing, home decoration, and the decorative arts. It contains 30 pages of color schemes from traditional sources, with mounted color swatches.

4. International Printing Ink Corporation. 1935. *Three Monographs on Color:* Color Chemistry, 18 pp., illus.; Color as Light, 21 pp., illus.; Color in Use, 18 pp. (+ 10), illus. International Printing Ink Corporation, Research Laboratories (New York).

*Color Technologist, Production and Marketing Administration, United States Department of Agriculture.

An excellent publication, beautifully illustrated in color, based on three lectures on color originally presented to printing, advertising, and color groups to cover the chemistry, physics, and psychology of color. Each volume is designed to cover the subject of one lecture.

5. Katz, David. 1935. *The World of Colour.* 300 pp., illus. Kegan Paul, Trench, Trubner & Co., Ltd. (London).

A very important book on the psychology of color, translated and abridged from the original first published in German in 1911. It discusses modes of appearance, film and surface colors, effect of illumination, light and dark adaptation, and color constancy.

6. Luckiesh, Matthew. 1915, 1921. *Color and Its Applications.* 357 pp., illus. D. Van Nostrand (New York).

This is probably the best of the many books published by Dr. Luckiesh on the subject of color. Written for popular consumption, some of them many years ago, the Luckiesh books cannot always be depended upon for accuracy in detail.

7. Massachusetts Institute of Technology. [Hardy, A. C.] 1936. *Handbook of Colorimetry.* 87 pp., illus. Mass. Inst. Tech. (Cambridge, Mass.).

A standard source of reference data for use in the application of the I.C.I. method of specification, particularly in converting spectrophotometric data to I.C.I. (Y, x, y)-data for equal energy or any of the three I.C.I. standard illuminants. Large-scale charts provide a transformation from I.C.I. data in terms of Illuminant C to dominant wave length and purity for Illuminant C.

8. Munsell, A. H. 1941. *A Color Notation.* 9th Ed. 74 pp., illus. Munsell Color Company, Inc. (Baltimore 2, Md.).

The latest (revised) edition of the original (1905) brief and lucid description of the Munsell color system, by its author.

9. Nickerson, Dorothy. 1945. *Color Measurement and Its Application to the Grading of Agricultural Products.* U. S. Dept. Agr. Misc. Pub. 580, 63 pp., illus. For sale by the Superintendent of Documents, Washington 25, D. C.

The most recent general treatise on colorimetry to be published. While it is concerned particularly with the subject indicated by the title, it provides a general course on colorimetric methods for the beginner, particularly in matters of color measurement and specification.

10. Ostwald, Wilhelm. *Colour Science.* Part I, Colour Theory and Standards of Colour (1931), 141 pp., illus.; Part II, Colour Measurement and Colour Harmony (1933), 173 pp., illus. Authorized translation with an introduction and notes by J. Scott Taylor. Winsor & Newton (London and New York).

The only published English translation of Ostwald's many books on color. In German there are 17 books, and over 50 articles, written by Ostwald on color, with many other articles on related subjects, all written after 1914. This translation was authorized by Ostwald. It covers the general principles of the Ostwald color system and presents many of his ideas regarding its application to problems of color harmony.

11. Parsons, Sir John Herbert. 1924. *An Introduction to the Study of Colour Vision.* 2nd Ed. 323 pp., illus. Cambridge University Press (London).

The best available reference book on the subject, though not without error. In case of doubt, source material should be consulted.

12. Pope, Arthur. 1929. *Introduction to the Language of Drawing and Painting.* Vol. I: The Painter's Terms (1929), 157 pp., illus.; Vol. II: The Painter's Modes of Expression (1931), 121 pp., illus. Harvard University Press (Cambridge, Mass.).

These two volumes by Professor Pope of Harvard University are included in this list because, without doubt, they provide the best general statement on the artist's part of matters relating to color that can be used to relate the points of view of artist and scientist.

13. Troland, Leonard T. 1929. *The Principles of Psychophysiology.* Vol. I: The Problems of Psychology; and Perception (1929), 429 pp., illus.; Vol. II: Sensation (1930), 397 pp., illus. D. Van Nostrand Company, Inc. (New York).

These two volumes are a standard reference work on the psychology and psychophysics of color. They are part of a four-volume series planned but not completed by Dr. Troland before his death. The 1921 O.S.A. Colorimetry Committee Report was written by Dr. Troland (aided by Irwin G. Priest and others), and these books provide an exposition of his thinking in the preparation of that report.

14. Wright, W. D. 1944. *The Measurement of Color.* 223 pp., illus. Adam Hilger (London). U. S. agents, Jarrell-Ash Co. (Cambridge, Mass.).

The most recent book in colorimetry by an author well qualified to discuss trichromatic colorimetry and its relation to the I.C.I. system of color specification. Seven chapters cover radiation and its modification by emission, absorption, and reflection; radiation and its reception in the eye; the trichromatic system of measurement; colorimeters, their design and use; spectrophotometry of color measurement; and practical applications of colorimetry.

Color Standards and Color Charts

There are three important standard color specifications that have no illustrations in chip form: the I.C.I., adopted in 1931 by the International Commission on Illumination; the A.S.A. standard, adopted by the American Standards Association as a war standard in this country in 1942; and the ISCC–NBS method of color designation, developed at the National Bureau of Standards on the basis of recommendations made by the Inter-Society Color Council in 1939. In addition there are a number of standards, notations, and names illustrated in chart form. As these are measured and specified in I.C.I. or A.S.A. terms, it becomes possible to convert from one chart to another, or from one specification to another. The most important and most widely known of these charts are listed here; many others of historical or more restricted use are omitted.

Color Standards

15. A.S.A. American Standards Association. 1942. American War Standard, "Specification and Description of Color," Z44-1942. (Copies available from American Standards Association, 70 East 45th Street, New York 17, N. Y. Price, 25 cents.)

A four-part standard which ties up the practical and scientific aspects of color work: Spectrophotometric, I.C.I., Munsell, and ISCC-NBS names. This standard was adopted by the A.S.A. at the request of industry in order to simplify the color specification problem during the war. It was jointly proposed and sponsored by the General Electric Company and the Interchemical Corporation.

16. I.C.I. Commission Internationale de l'Eclairage. 1931. Proceedings of the 8th session, pp. 19–29. Cambridge, England.

The several resolutions relating to colorimetric standardization are reported here. Although published in England, the original language is French; therefore the standards are known either as C.I.E. (in England and France) or I.C.I. (in the United States).

The resolutions concern the adoption of a standard observer, standard illuminants, standard conditions of illuminating and viewing for colorimetry.

17. ISCC-NBS. Judd, D. B., and Kelly, K. L. 1939. Method of designating colors. *J. Research,* [U. S.] *Nat. Bur. of Standards* (RP 1239) **23**: 355–85, illus. Copies obtainable from Government Printing Office. Price, 10 cents.

This naming method was proposed by a committee of the Inter-Society Color Council and the details were subsequently worked out at the National Bureau of Standards, in answer to a request from the review committee of the *U. S. Pharmacopoeia* for a standard

method of designating colors that would be useful to both scientist and layman. The result should be brought to the attention of every industry and trade that uses colors. Each name in the system is intended to designate a whole group of colors; for example, "light brown" or "dark red." The importance of the contribution lies in the simplicity and logic of the naming method and in the fact that the limits for each color name are specified.

Color Charts

18. *British Colour Council Dictionary of Colour Standards,* 2 vols., 1934 (London).

One volume consists of 220 color standards on ribbon developed by the British Colour Council "to place colour determination for the British Empire in British hands; to obtain advance information about fashion tendencies; and to provide standard names for colours. . . ." These standards were adopted by the British Standards Institution as British Standard No. 543—1934. The second volume consists of a dictionary of color names, with references to samples in this and other standard charts, a table of Lovibond tintometer readings, and a table of I.C.I. measurements made on the Guild Trichromatic Colorimeter (Illuminant B) for the 220 standard samples.

19. Jacobson, Egbert. 1942. *The Color Harmony Manual.* 12 complementary charts, separately bound, and 1 vol., 22 pp., illus. Container Corporation of America (Chicago).

A neatly presented arrangement of 680 color chips mounted according to 24 Ostwald triangles, each pair of complementary triangles bound singly. A thirteenth volume contains a brief description of the *Manual* and how to use it. The chips, glossy on one side and dull on the other, are removable for comparison and use. Colorimetric data, based on measurements on the dull side of the chips, have been published (*J. Optical Soc. Am.* **34**, 382–95 (1944)).

The Ostwald system represented by the chips in this *Manual* is intended to preserve the Ostwald concepts of a monochromatic triangle (constant dominant wave length), complementarism of opposite triangles, and constant chromaticity in the shadow series. To prepare such a series, both the Ostwald concept of an equi-spaced hue circle and of the equation $W + B + C = 1$ had to be abandoned in order that use of existing color gamuts might be made. This undoubtedly is the best representation of the Ostwald system.

20. Maerz, A., and Paul, M. Rea. 1930. *A Dictionary of Color.* 207 pp., illus. (56 plates). McGraw-Hill (New York).

This dictionary is the foremost authority for defining color names in use today. The arrangement on each chart was designed for convenience in printing a large number of colors. No attempt was made to follow or create any system based on this arrangement. There are 56 charts, containing 7,056 colors, with a useful text of 73 pages. The size of most samples is ½ by $^{11}/_{16}$ inch. The charts represent the designated color names more accurately than is possible with most printed charts because the color printing was done before the color names were assigned to samples on the charts.

21. Munsell Color Company, Inc. 1929, 1942. *Munsell Book of Color.* Standard library size edition, 20 hues and 40 hues; pocket-sized edition, 20 hues and 40 hues (Baltimore 2, Md.).

The Munsell system is based on a three-dimensional color space devised on a psychological system of visually equal steps for the three color attributes: hue, value, and chroma. Charts representing various maps of this color space are provided in two sizes—a large one for library or teaching purposes and a small one for laboratory work—in one volume of 20 hues (1929) or 2 volumes of 40 hues (1942). There are 421 colors in the 20-hue series and 982 in the 40-hues. Samples on the large charts are ⅝ by ⅞ inch; on the pocket-size charts they are ½ by ⅝ inch. The charts are removable for ready use. They are undoubtedly the most widely used series of color charts available today. They are useful not only in themselves but also because decimal color notations may be interpolated or extrapolated by comparison with color chips on the charts.

I.C.I. colorimetric data are published for the color chips of the Munsell system, and a smoothed series of Munsell diagrams reported by an O.S.A. sub-

committee (*J. Optical Soc. Am.* **33**, July, 1943, pp. 355–422), makes it possible to convert into Munsell notation any color specification that is available in I.C.I. terms. The Munsell notation is a part of the four-part standard for color adopted by the American Standards Association (Z44) in 1942.

22. Ostwald, Wilhelm. 1932, 1935. *The Ostwald Colour Album.* Arranged by J. Scott Taylor. Illus. (12 plates, 680 colors). Winsor & Newton (London and New York).

Twelve plates are bound two each in a series of 6 folders. Plate 1 consists of diagrams of the Ostwald triangle arrangement (no color chips); plate 2 contains the gray scale of 8 chips. Plates 3–12 contain vertical arrangements in 2 each of the 24 Ostwald hues for constant Black and White Content. When these charts are turned 90°, the plates present the Ostwald shadow series, 24 hues in each of 7 series, a total of 672 color chips. These plus the 8 neutrals make the 680 that are usual in an abridgment of the Ostwald charts. The chips are $\frac{7}{16}$ inch square, mounted on black.

Although it is understood that the color chips in these charts are quite as good as those in the original Ostwald series, and were approved by Ostwald himself, the arrangement of the colors and their obvious unevenness makes their use for any practical work except teaching seem doubtful. They are intended to accompany the two-volume English translation of Ostwald made by J. Scott Taylor.

23. Ridgway, Robert. 1912. *Color Standards and Color Nomenclature.* [44] pp., illus. A. Hoen & Co. (Baltimore, Md.).

This edition is widely used for description of color in the biological sciences. The charts are based on 36 hues reduced by regular proportions of white, gray, and black to give systematic groupings. The first charts represent "tints" and "shades" of "broken colors," the full colors being reduced with a definite amount of gray. Each of the 1,113 colors on the charts is named.

The production of these charts in 1912 was a remarkable piece of work. While still used in certain fields, their use is relatively restricted today because other systematic arrangements are now available, some of them measured in standard colorimetric terms, which allows conversion from the terms of one chart to those of any other that have also been measured.

24. The Textile Color Card Association of the United States, Inc. 1941. *Standard Color Card of America.* 9th Ed. (revised); illus. *Annual Spring Color Card; Fall Color Card; U. S. Army Color Card* (New York).

These color cards show standard and seasonal colors with names adopted by the association for the American textile industry which it represents. There are 216 samples in the standard card, each of satin-backed crepe, about 2½ inches square, folded to show the color of both glossy and dull surfaces. Within a few months I.C.I. and Munsell specifications for these standards will be made available by the Textile Color Card Association as a result of research studies initiated by them and carried out at the National Bureau of Standards.

Color Tests

Color-Blindness

Tests for color-blindness published in the form of polychromatic plates are not the only tests for color-blindness. There are yarn tests, bead tests, card tests, lantern tests, as well as anomaloscope-type tests and the Farnsworth tests, that may be used for research purposes. None is completely satisfactory, even the research-type test, but if competently administered many of them can serve to screen out cases of greatest interest. The polychromatic plate type is probably the quickest and easiest to procure and administer and is therefore most widely used as a screening test. Prior to the war the Ishihara test was probably the best known of these. The few copies of the Rabkin test received before the war are jealously held by their owners, for they seem so far superior to other published tests. Four of these polychromatic-type tests are listed. For a critical estimate of these tests reference may be had to a series of reports published in the *Journal of the Optical Society*, beginning in April, 1945, by Hardy, Rand, and Rittler of Knapp Memorial Laboratory, Institute of Ophthalmology, New York City.

25. American Optical Company. 1940. *Pseudo-Isochromatic Plates for Testing Color Perception.* 11 pp., illus. (46 plates). (Southbridge, Mass.)

These tests, published by the American Optical Company for and at the request of the armed services, include copies of plates from both the Ishihara and Stilling's tests which it was feared might not be available in this country during the war years. Widely used for testing color perception during the war.

26. Ishihara, S. 1921. *The Series of Plates Assigned as Tests for Color-Blindness,* 5th Ed. 6 pp., illus. (16 plates). Kanehara (Tokyo). U. S. agents, C. H. Stoelting (Chicago).

Several editions of this test have been published, some better than others.

27. Rabkin, E. B. 1939. *Polychromatic Plates for Testing Color Vision,* 2nd Ed. [40] pp., illus. (20 plates). Ukranian Hirshman Ophthalmic Institute (U.S.S.R.).

The best test of this type yet published.

28. [Stilling, J.] 1940. *Pseudo-Isochromatic Plates for Testing Color Perception.* Amer. Ed. [7] pp., illus. (35 plates). E. B. Meyrowitz Surgical Instruments Co., Inc. (New York).

There are several editions in this country and abroad of Stilling's plates. This latest one seems less successful than other previous editions.

Color Aptitude

Tests for color aptitude are newer but perhaps even more important in textile color-matching work than tests for so-called "color-blindness." A test to discover the ability of an observer to make fine color discriminations has been developed by a subcommittee of the Inter-Society Color Council in answer to requests from the textile industry. Although still in an experimental stage the test is available and textile groups have shown particular interest in it.

29. Color Aptitude Test Committee of the Inter-Society Color Council. 1944. *Color Aptitude Test—1944 Experimental Edition.*

Distributed for the Committee by the Munsell Color Co., 10 East Franklin Street, Baltimore 2, Md.

The Eye

The following three remarkable books on the eye have been published in recent years, all of them authoritative.

30. Kronfeld, Peter C., *et al.* 1943. *The Human Eye in Anatomical Transparencies.* 99 pp., 87 illus. Historical appendix by Stephen L. Polyak, illustrations by Gladys M. High. Bausch & Lomb Press (Rochester, N. Y.).

By means of a series of transparent plates the eye is dissected in an unusual and easily grasped presentation.

31. Polyak, Stephen L. 1941. *The Retina.* 607 pp., illus. University of Chicago Press (Chicago).

A careful and detailed treatment by an outstanding authority in this field. Easily the best book available on this subject. It includes the anatomy and histology of the retina of man, ape, and monkey, and the consideration of visual functions, the history of physiological optics, and histological laboratory technique.

32. Walls, Gordon L. 1942. *The Vertebrate Eye and Its Adaptative Radiation.* 785 pp., illus. Cranbrook Institute of Science, Bulletin No. 19 (Bloomfield Hills, Mich.).

A readable book for one that covers at length such a specialized and technical subject. It is divided into three parts. The second part includes three highly interesting chapters that deal with color vision in animals, dermal color changes, and coloration of the eye.

Periodical Literature

References Covering the General Field

33. *O.S.A. Colorimetry Committee Report.* If references on color were limited to one, this report should be it. A committee of many experts has been assembling the material for this book for several years. In order not to delay publication until postwar completion of the book, a preface and five out of nine chapters have been published (1943–1945) in the *Journal of the Optical Society of America.* The other four chapters will not appear until publication of the report in book form. A list

of the published chapters, with reference to publication in the *Journal of the Optical Society,* follows. Single copies of the *Journal* may be obtained from the Institute of Physics, 57 East 55th Street, New York 22, N. Y., at 70 cents each.

(*a*) 1943. Preface: "The Historical Background and Evolution of the Colorimetry Report," L. A. Jones (**33**, No. 10, pp. 534–43; refs. 1–16).

(*b*) 1943. Chapter II: "The Concept of Color" (**33**, No. 10, pp. 544–54, illus.; refs. 201–8).

(*c*) 1944. Chapter V: "Physical Concepts: Radiant Energy and Its Measurement" (**34**, No. 4, pp. 183–218, illus.; refs. 501–73).

(*d*) 1944. Chapter VI: "The Psychophysics of Color" (**34**, No. 5, pp. 245–66, illus.; refs. 601–30).

(*e*) 1944. Chapter VII: "Quantitative Data and Methods for Colorimetry" (**34**, No. 11, pp. 633–88, illus.; refs. 701–60).

(*f*) 1945. Chapter IX: "Colorimeters and Color Standards" (**35**, No. 1, pp. 1–25, illus.; refs. 801–99).

34. *Inter-Society Color Council Symposia.* In 1938 the Inter-Society Color Council held its first symposium on color. The Optical Society of America arranged for publication of the papers in its *Journal.* Since that time, annually, or sometimes more often, symposia have been jointly held, sponsored, or arranged by the Council and one or more of its member bodies. Generally the papers have been published in the *Journal* or a publication of the co-sponsoring member body, with bound reprints made available. Copies of 9 such symposia are available from the Inter-Society Color Council, Box 155, Benjamin Franklin Station, Washington 4, D. C. Many of the articles contain good reference lists.

(*a*) *Symposium held jointly with the Optical Society of America, February, 1938.* Four papers on the history and use of Hardy-General Electric Recording Spectrophotometer, and one paper on designation of theatrical filters: *J. Optical Soc. Am.* **28**, No. 10, 356–97 (1938), illus. Supply for free distribution exhausted.

(*b*) *Symposium held jointly with the American Psychological Association, February, 1939.* Six papers on color tolerance. *Am. J. Psychol.* **52**, 383–448 (July), illus. Bound copy, 50 cents.

(*c*) *Symposium held jointly with the Technical Association of the Pulp and Paper Industry, February, 1940.* Eight papers on color in the pulp and paper industry. *Technical Association Paper* **23**, 473–525 (June, 1940); and TAPPI Section of *Paper Trade J.* **111**, No. 10 *et seq.* (Sept.–Oct., 1940). Bound copy, $1.00.

(*d*) *Symposium held jointly with the Illuminating Engineering Society, September, 1940.* Four papers on color vision, color determination, color systems, and illuminants in color determination. Bound preprints available. *Illuminating Engineering* **36**, 293–399, illus. (Mar., 1941).

(*e*) *Symposium held jointly with the American Society for Testing Materials, March, 1941.* Six papers on color, its specification and use in evaluating the appearance of materials, including discussion. 79 pp., illus. (1941). Bound copies available from headquarters of the American Society for Testing Materials, 260 S. Broad Street, Philadelphia 2, Pa. Cloth, $1.25; paper cover, $1.00.

(*f*) *Symposium held jointly with the American Ceramic Society, March, 1941.* Six papers on color in the ceramic industry. Bound reprints available. *Bulletin of The American Ceramic Society* **20**, No. 11, 375–411, illus. (1941).

(*g*) *Symposium held at the Metropolitan Museum of Art, February, 1942.* Four papers on color in art education. *J. Optical Soc. Am.* **32**, No. 12, 698–726, illus. (1942), bound; also four class outlines, mimeographed. Reprints exhausted.

(*h*) *Symposium arranged for the Optical Society of America, March, 1943.* Three papers on color-blindness, five papers on color-blindness tests. *J. Optical Soc. Am.* **33**, June, Sept. and Oct., 1943. Limited supply of bound reprints available.

(*i*) *Discussion session sponsored jointly by the American Association of Textile Chemists and Colorists and the Federation of Paint and Varnish Production Clubs, March, 1944.* Papers and discussion on "Small Color Differences." *Am. Dyestuff Reptr.* **33**, Nos. 11–14 (May 22,

June 5, 19, July 3, 1944). Limited supply of bound reprints available.

On the Munsell System

Two volumes of the *Journal of the Optical Society of America* have been devoted in recent years to reports on the Munsell system. In December, 1940, the first group of papers appeared, followed in July, 1943, by a second group. The information in these papers is not available in book form.

35. *J. Optical Soc. Am.* **30**, 573–645 (Dec. 1940).

(*a*) Judd, D. B. "The Munsell Color System." Foreword (573).

Mr. Munsell's search for a psychophysical system whose notations should correspond with what an observer sees was rewarded with one which fulfills the condition to a surprising degree, and one purpose of grouping the following papers in a single issue of the *Journal* is to bring out the much misunderstood relations between psychological and psychophysical systems.

(*b*) Nickerson, Dorothy. "History of the Munsell Color System and Its Scientific Application" (575–86; 31 refs.).

This report follows the development of the system by A. H. Munsell from 1900, covers highlights of the Munsell color diary, and development and studies on the system that followed the death of A. H. Munsell in 1918, culminating in publication of the charts of the new *Book of Color* in 1929. Lists references to practically all early work in this field.

(*c*) Tyler, J. E., and Hardy, A. C. "Analysis of the Original Munsell Color System" (587–90).

Consists chiefly of a table of I.C.I. tristimulus data for a system based on adjusted values of original Munsell colors, calculated according to definitions suggested or published by Munsell for constructing a system by additive mixtures on a Maxwell disc. Although the authors of this paper believed that they were describing the original Munsell system, a study of Munsell charts shows that even the earliest charts departed from this system whenever its strict interpretation came into conflict with visually equi-spaced color scales.

(*d*) Gibson, K. S., and Nickerson, Dorothy. "Analysis of the Munsell Color System Based on Measurements Made in 1919 and 1926" (591–608, illus.).

A study of the original Munsell system by means of measurements made in 1919 and 1926 of color scales and charts produced by A. H. Munsell in his *Atlas of the Munsell Color System,* to see how nearly he followed interpretations and principles stated in his writings. Formulas and relationships given in the Tyler-Hardy report are analyzed and derived. In summary: (1) The relation of early Munsell value and luminous apparent reflectance $V^2 = 100\,k(Y - 0.007)$ was confirmed in a general way; (2) the relation between Atlas hue and dominant wave length showed significant deviations from 1-to-1 correspondence; (3) departures from the psychophysical system were in the direction to give perceptually more uniform chroma scales.

(*e*) Glenn, J. J., and Killian, J. T. "Trichromatic Analysis of the *Munsell Book of Color*" (609–16).

A table of I.C.I. tristimulus data for Illuminant C for the more than 400 color samples in the 1929 edition of the *Munsell Book of Color.* Dominant wave length and excitation purity are reported. The data are based on spectrophotometric measurements made at M.I.T. in Professor A. C. Hardy's laboratory.

(*f*) Newhall, S. M. "Preliminary Report of the O.S.A. Subcommittee on the Spacing of the Munsell Colors" (617–45, illus.; 86 refs.).

The spacing problem consists in the detection and correction of errors of allocation in surface-color space of the regular samples of the 1929 *Munsell Book of Color.* Data are summarized for visual estimates of color spacing made by various observers over a 5-year period. These data provide the psychological basis for smoothing the contours in the final report.

36. *J. Optical Soc. Am.* **33**, 355–421 (July, 1943).

(*a*) Kelly, K. L., Gibson, K. S., and Nickerson, Dorothy. "Tristimulus Specification of the *Munsell Book of Color* from Spectrophotometric Measurements" (355–76, illus.; 23 refs.).

The development of the Inter-Society Color Council-National Bureau of Standards (ISCC-NBS) system of color names is based on Munsell standards. Master standards of these Munsell papers were meas-

ured, and details of spectrophotometric measurement and calibration are given. The paper consists chiefly of a table and diagrams giving tristimulus specifications for about 400 Munsell samples. Results for Illuminant C repeat the work (on NBS master standards) of the Glenn-Killian report. To provide data for a wide range of illuminants, colorimetric data are also reported for I.C.I. Illuminant A (tungsten), an illuminant called "D" (Macbeth 7500°K, representative of a lightly overcast northern sky), and one called "S" (representative of an extremely blue sky).

(*b*) Granville, W. C., Nickerson, Dorothy, and Foss, C. E. "Trichromatic Specifications for Intermediate and Special Colors of the Munsell System" (376–85, illus.; 11 refs.).

This report consists of tables of I.C.I. trichromatic specifications for Illuminant C, and dominant wave length and purity, for several hundred Munsell color samples not reported by Glenn-Killian or Kelly-Gibson-Nickerson. Data are included for 20 additional intermediate hues, additional neutrals, several series of special samples including 100 hues at 5/5, 50 hues at maximum chroma, 9/ values for 5 hues, /1 chroma for 5 hues, a special series of strong chromas, and glossy-surface papers for measuring tomato colors.

(*c*) Newhall, S. M., Nickerson, Dorothy, and Judd, D. B. "Final Report of the O.S.A. Subcommittee on the Spacing of the Munsell Colors" (358–418, illus.; 35 refs.).

This report presents the characteristics of a modified and enlarged Munsell solid evolved from visual estimates of Munsell samples, and based on a careful review and revision of all three dimensions. A solid is achieved which approaches more closely to A. H. Munsell's dual ideal of psychological equispacing and precise applicability. The new solid is defined in terms of the I.C.I. coordinate system and Illuminant C, and a table of re-notations is given for Munsell color samples.

A sound and useful work which in the next 15 years should have as much effect upon practical colorimetry as adoption of I.C.I. standards has had in the past 15 years.

(*d*) Nickerson, Dorothy, and Newhall, S. M. "A Psychological Color Solid" (419–21, illus.; 13 refs.).

In preparation of the report on smoothing the Munsell colors, data became available which permit, for the first time, an approximate fulfillment of the requirements for an ideal psychological solid in cylindrical coordinates. Tables and photographs of models constructed on this basis are included in the report, also an estimate, based on these models, of the number of distinguishable colors.

On the Ostwald System

In 1944 the papers of a symposium on the Ostwald color system, presented at the 1944 spring meeting of the Optical Society, were published in one number of the *Journal*. The information in these papers is not available elsewhere.

37. *J. Optical Soc. Am.* **34**, 353–99 (July, 1944).

(*a*) Judd, D. B. "Symposium on the Ostwald Color System"—Foreword (353–4).

It is a matter of both scientific and practical importance to determine whether Ostwald or his critics have correctly appraised the value of his contribution to colorimetry. This symposium of papers is expected to provide the basis for such an appraisal.

(*b*) Zeishold, Herman. "Philosophy of the Ostwald Color System" (355–60).

This discussion, by a well trained and naturally thoughtful chemist, but one untrained in color science, presents the Ostwald system in very much the manner that Ostwald himself does.

(*c*) Foss, C. E., Nickerson, Dorothy, and Granville, W. C. "Analysis of the Ostwald Color System" (361–81, illus.; 68 refs.).

This paper contains more data on the Ostwald system than have heretofore been reported in either the German or the English language. Because of its technical nature it will not be read by many of the people who should understand its implications. It presents certain of the Ostwald concepts, develops from them an ideal Ostwald color solid in terms of modern colorimetry (the I.C.I. standard observer and coordinate system), and indicates how material representations relate to the ideal. There is little discussion in the paper; three-quarters of it consists of tables and figures working out this ideal system completely for the first time in I.C.I. terms, thus providing a basis for the reader to evaluate the Ostwald contribution.

In producing samples to correspond with the ideal Ostwald system presented, it is pointed out that decisions have to be made regarding which of several Ostwald principles will be used. This is necessary because the various principles he lays down are mutually exclusive. For example: (1) one cannot have both equally spaced hues of near Full Colors and also have these hues form complementary pairs (a study of Ostwald's own samples shows that lack of complementarism was sacrificed in favor of more equal visual steps); (2) samples in which black, white, and a single chromatic colorant are used will almost always depart from constant dominant wave length (this is true of many of the Ostwald samples measured); and (3) samples following strictly the disc mixture proportions of the Ostwald equation $W + B + C = 1$ with any real colorant would exclude many colors possible to produce with present-day colorants (particularly in the range of light, strong colors) and would require (particularly in the dark colors) many colors that it is not possible to produce with present colorants.

(*d*) Granville, W. C., and Jacobson, Egbert. "Colorimetric Specification of the Color Harmony Manual from Spectrophotometric Measurements" (382–95, illus.).

A brief description and discussion of the Jacobson *Color Harmony Manual* is reported. There are full tables of I.C.I. colorimetric data based on spectrophotometric curves (made on the dull side of each sample) of the 680 Ostwald chips in the 12 handbooks of the *Manual*. The chips were made by C. E. Foss on the basis of the study reported by Foss-Nickerson-Granville. Measurements of previously made Ostwald samples are reported, and comparisons to this new set of material are made.

On the basis of this report it may be concluded that the chips of the *Color Harmony Manual* represent the closest approach to date to an ideal abridged Ostwald system. They were developed to preserve the general Ostwald concepts of (1) monochromatic triangles with constant dominant wave length, (2) the concept of complementarism of opposite triangles, and (3) the concept of constant chromaticity in each shadow series, other Ostwald concepts being discarded as necessary to preserve these three.

(*e*) Birren, Faber. "Application of the Ostwald Color System to the Design of Consumer Goods" (396–9).

A personal history by an active commercial colorist of his view of the Ostwald system and of its use in the commercial field.

On Color Preferences

Colonel Guilford's work in this field is outstanding. The following reports are summaries of the first part of a program of systematic psychological investigation which it is hoped the author will continue after his release from the Armed Forces. There are other papers by Guilford, and some few reports by others, on the subject of color preferences. The following papers include charts presenting summaries of relationships found to date.

38. Guilford, J. P. 1939. "A Study in Psychodynamics." *Psychometrika* **4**, 1–23, illus. (Mar.).

39. Guilford, J. P. 1940. "There is System in Color Preferences." *J. Optical Soc. Am.* **30**, 455–9, illus.

ABSTRACTS

SERVICES AVAILABLE

Reprints of the original articles abstracted in TEXTILE RESEARCH JOURNAL *are often available from the publishers. Otherwise, it may be possible to secure copies of the periodicals. Orders should be sent direct to the publishers.*

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Microfilm copies and paper enlargements of microfilm may be obtained from: Microfilms Inc., 313 N. First St., Ann Arbor, Mich.; New York Public Library, New York, N. Y.; Yale University Library, New Haven, Conn.; Harvard University Library, Cambridge, Mass.; and Library of Congress, Washington, D. C. Translations may also be obtained from the above sources.

Subscriptions to reprints of the Abstracts section for Volume 16, 1946, are now available to subscribers to the JOURNAL. *These are printed on one side of the sheet for clipping and filing in a card index system. The charge for this service is $3.00.*

A list of periodicals, the abbreviations used in references to articles, and the addresses of publishers of English language publications is given below.

List of Periodicals Abstracted

American

Name and Address of Journal	*Customary Abbreviation*
Advances in Carbohydrate Chemistry Advances in Protein Chemistry Academic Press, Inc., 125 E. 23rd St., New York 10, N. Y.	Advances in Carbohydrate Chem. Advances in Protein Chem.
American Dyestuff Reporter 1 Madison Ave., New York 10, N. Y.	Am. Dyestuff Reptr.
American Society for Testing Materials, Bulletin 260 South Broad St., Philadelphia, Pa.	ASTM Bull.
American Wool and Cotton Reporter 530 Atlantic Ave., Boston 10, Mass.	Am. Wool and Cotton Reptr.
Bibliography of Scientific and Industrial Reports U. S. Department of Commerce, Office of the Publication Board, Washington 25, D. C.	Bib. Sci. and Ind. Reports
Bulletin of the Institute of Paper Chemistry Appleton, Wis.	Bull. Inst. Paper Chem.
Chemical Abstracts Ohio State University, Columbus 10, Ohio	Chem. Abstr.
Chemical and Engineering News 1155 16th St., N.W., Washington 6, D. C.	Chem. and Eng. News
Chemical Industries 522 Fifth Ave., New York 18, N. Y.	Chemical Industries
Chemical and Metallurgical Engineering 330 W. 42nd St., New York 18, N. Y.	Chem. and Met. Eng.
Chemical Reviews Mt. Royal and Guilford Aves., Baltimore, Md.	Chem. Rev.

Name and Address of Journal	*Customary Abbreviation*
Chemist-Analyst, The J. T. Baker Chemical Co., Phillipsburg, N. J.	Chemist-Analyst
Chemurgic Digest 50 W. Broad Tower, Columbus, Ohio	Chemurgic Digest
Chronica Botanica (The International Plant Science News Magazine) Chronica Botanica Co., Waltham, Mass.	Chronica Botan.
Cotton 1020 Grant Building, Atlanta 3, Ga.	Cotton
Electronic Industries 480 Lexington Ave., New York 17, N. Y.	Electronic Ind.
Fibre and Fabric Wade Publishing Co., 465 Main St., Cambridge, Mass.	Fibre and Fabric
Foreign Agriculture U. S. Bureau of Agricultural Economics, Washington, D. C.	Foreign Agri.
Foreign Commerce Weekly Supt. of Documents, Govt. Printing Office, Washington 25, D. C.	Foreign Commerce Weekly
India Rubber World 420 Lexington Ave., New York, N. Y.	India Rubber World
Industrial and Engineering Chemistry Industrial and Engineering Chemistry, Analytical Edition 1155 16th St., N. W., Washington 6, D. C.	Ind. Eng. Chem. Ind. Eng. Chem., Anal. Ed.
Interchemical Review 432 W. 45th St., New York 19, N. Y.	Interchem. Rev.
Journal of Agricultural Research Supt. of Documents, Govt. Printing Office, Washington 25, D. C.	J. Agr. Research
Journal of the American Chemical Society 120 Oxford St., Cambridge, Mass.	J. Am. Chem. Soc.
Journal of the American Leather Chemists Association 143 W. 20th St., New York 11, N. Y.	J. Am. Leather Chem. Assoc.
Journal of American Society of Agronomists Iowa State College, Ames, Iowa	J. Am. Soc. Agron.
Journal of Applied Physics 57 E. 55th St., New York 22, N. Y.	J. Applied Phys.
Journal of Biological Chemistry Mt. Royal and Guilford Aves., Baltimore, Md.	J. Biol. Chem.
Journal of Chemical Education 20th and Northampton Sts., Easton, Pa.	J. Chem. Ed.
Journal of Chemical Physics 57 E. 55th St., New York 22, N. Y.	J. Chem. Phys.
Journal of Colloid Science Academic Press, Inc., 125 E. 23rd St., New York 10, N. Y.	J. Colloid Sci.
Journal of the Franklin Institute Benjamin Franklin Parkway at 20th St., Philadelphia, Pa.	J. Franklin Inst.
Journal of the Optical Society of America American Inst. of Physics, 57 E. 55th St., New York 22, N. Y.	J. Opt. Soc. Am.
Journal of Organic Chemistry Mt. Royal and Guilford Aves., Baltimore, Md.	J. Org. Chem.

Name and Address of Journal	*Customary Abbreviation*
Journal of Physical Chemistry Mt. Royal and Guilford Aves., Baltimore, Md.	J. Phys. Chem.
Journal of Research, National Bureau of Standards Washington 25, D. C.	J. Research Natl. Bur. Standards
Kodak Research Laboratories, Monthly Abstract Bulletin Eastman Kodak Co., Rochester, N. Y.	Kodak Mo. Abstr. Bull.
Modern Industry 347 Madison Ave., New York 17, N. Y.	Modern Ind.
Modern Plastics 122 E. 42nd St., New York 17, N. Y.	Modern Plastics
Oil and Soap Gillette Publishing Co., 400 W. Madison St., Chicago, Ill.	Oil and Soap
Pacific Plastics Los Angeles, Calif.	Pacific Plastics
Paper Mill and Wood Pulp News L. D. Post, Inc., 1440 Broadway, New York, N. Y.	Paper Mill News
Paper Trade Journal 15 W. 47th St., New York 19, N. Y.	Paper Trade J.
Physical Review The American Inst. of Physics, 57 E. 55th St., New York 22, N. Y.	Phys. Rev.
Plastics Ziff-Davis Publishing Co., Chicago, Ill.	Plastics (Chicago)
Plastics and Resins 299 Madison Ave., New York 17, N. Y.	Plastics and Resins
Polymer Bulletin 94 Livingston St., Brooklyn, N. Y.	Polymer Bull.
Rayon Organon 10 E. 40th St., New York 16, N. Y.	Rayon Organon
Rayon Textile Monthly 303 Fifth Ave., New York 16, N. Y.	Rayon Text. Mo.
Review of Scientific Instruments 57 E. 55th St., New York 22, N. Y.	Rev. Scientific Instruments
Reviews of Modern Physics 57 E. 55th St., New York 22, N. Y.	Rev. Modern Phys.
Rubber Age 250 W. 57th St., New York 19, N. Y.	Rubber Age (New York)
Rubber Chemistry and Technology 1012 Second National Building, Akron 1, Ohio	Rubber Chem. Tech.
Saco-Lowell Bulletin, Saco-Lowell Shops 60 Batterymarch St., Boston, Mass.	Saco-Lowell Bull.
Science The Science Press, Lancaster, Pa.	Science

Name and Address of Journal	*Customary Abbreviation*
Soap and Sanitary Chemicals 254 W. 31st St., New York 1, N. Y.	Soap San. Chem.
Synthetic Organic Chemicals Eastman Kodak Co., Rochester, N. Y.	Synthetic Org. Chemicals
Technology Review Mass. Inst. of Technology, Cambridge, Mass.	Tech. Rev.
Textile Age 381 Fourth Ave., New York 16, N. Y.	Textile Age
Textile Bulletin 218 W. Morehead St., Charlotte, N. C.	Textile Bulletin
Textile Colorist and Converter 1 Madison Ave., New York 10, N. Y.	Text. Col. and Converter
Textile World 330 W. 42nd St., New York 18, N. Y.	Textile World

British Empire

Biochemical Journal, The Cambridge University Press, Fetter Lane, London E. C. 4, England	Biochem. J.
British Plastics Dorset House, Stamford St., London S.E. 1, England	Brit. Plastics
Canadian Chemistry and Process Industries 137 Wellington St. W., Toronto 1, Ont.	Can. Chem. and Proc. Ind.
Canadian Journal of Research National Research Council, Ottawa, Canada	Can. J. Research
Canadian Textile Journal 1434 St. Catherine St. W., Montreal, Canada	Can. Text. J.
Chemistry and Industry 56 Victoria St., London S.W. 1, England	Chemistry and Industry
Current Science Indian Institute of Science, Hebbal P. O., Bangalore, India	Current Science
Dyer, Textile Printer, Bleacher and Finisher, The Heywood & Co., Ltd., Drury House, Russell St., Drury Lane, London W.C. 2, England	Dyer
Engineer, The 28 Essex St., Strand, London W.C. 2, England	The Engineer
Fibres 17 Stratford Place, London W. 1, England	Fibres
Indian Textile Journal Military Square, Fort Bombay, India	Indian Text. J.
Journal of the Chemical Society Burlington House, London W. 1, England	J. Chem. Soc.
Journal of the Institution of Electrical Engineers (London), The Savoy Place, Victoria Embankment, London W.C. 2, England	J. Inst. Elec. Engrs.

Name and Address of Journal	*Customary Abbreviation*
Journal of Scientific and Industrial Research (India) Council of Scientific and Industrial Research, New Delhi, India	J. Sci. and Ind. Research
Journal of Scientific Instruments Institute of Physics, Lowther Gardens, Exhibition Rd., South Kensington, London S.W. 7, England	J. Sci. Instruments
Journal of the Society of Chemical Industry 56 Victoria St., London S.W. 1, England	J. Soc. Chem. Ind.
Journal of the Society of Dyers and Colourists The University, Leeds, England	J. Soc. Dyers and Colourists
Journal of the Textile Institute 16 St. Mary's Parsonage, Manchester, England	J. Text. Inst.
Nature Macmillan & Co., Ltd., St. Martin's St., London, England	Nature
New Zealand Journal of Science and Technology Government Printer, Wellington, N. Z.	New Zealand J. Sci. and Tech.
Paper-Maker and British Paper Trade Journal, The 47 Cannon Street, London E.C. 4, England	Paper-Maker
Physics Abstracts Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, London W.C. 2, England	Phys. Abstr.
Proceedings of the Physical Society 1 Lowther Gardens, London S.W. 7, England	Proc. Phys. Soc.
Proceedings of the Royal Society Cambridge University Press, 200 Easton Rd., London N.W. 1, England	Proc. Roy. Soc.
Science and Culture Indian Press, Ltd., 93A Dhurrumtola St., Calcutta, India	Science and Culture
Silk Journal and Rayon World Old Colony House, S. King St., Manchester 2, England	Silk J. Rayon World
Silk and Rayon St. James House, 44 Brazennose St., Manchester 2, England	Silk and Rayon
Textile Journal of Australia 19–47 Jeffcott St., Melbourne, Australia	Text. J. Australia
Textile Manufacturer 21 Bedford St., Strand, London W.C. 2, England	Text. Mfr.
Textile Mercury and Argus 41 Spring Gardens, Manchester, England, or 146 Fleet St., London E.C. 4, England	Text. Mercury and Argus
Textile Recorder Old Colony House, S. King St., Manchester, England	Text. Recorder
Textile Weekly, The The Textile Press, Ltd., 49 Deansgate, Manchester 3, England	Text. Weekly
Transactions of the Faraday Society 33 Paternoster Row, London, England	Trans. Faraday Soc.

Name and Address of Journal	*Customary Abbreviation*
Dutch	
Recueil des travaux chimiques des Pays-Bas	Rec. Trav. Chim.
French	
Comptes rendus hebdomadaires des séances de l'académie des sciences	Compt. rend.
Journal de chimie physique et Revue générale des colloïdes	J. Chim. Phys.
Teintex	Teintex
German	
Angewandte Chemie	Angew. Chem.
Cellulosechemie	Cellulosechem.
Chemisches Zentralblatt	Chem. Zentr.
Collegium	Collegium
Deutsche Farber-Zeitung	Deut. Farber-Zeit.
Journal für practische Chemie	J. pract. Chem.
Klepzigs Textil-Zeitschrift	Klepzigs Textil-Z.
Kolloid-Zeitschrift	Kolloid-Z.
Kunstseide und Zellwolle	Kunstseide u. Zellwolle
Melliand Textilberichte	Melliand Textilber.
Naturwissenschaften	Naturwissenschaften
Planta	Planta
Spinner und Weber	Spinner u. Weber
Wasser und Abwasser	Wasser u. Abwasser
Zeitschrift für physikalische Chemie	Zeit. physik. Chem.
Zeitschrift des Vereines deutscher Ingenieure	Z. Ver. deut. Ing.
Zellwolle, Kunstseide, Seide	Zellwolle, Kunstseide, Seide
Irish	
Fibres, Fabrics and Cordage	Fibres, Fabrics and Cordage
Italian	
Laniera	Laniera
Russian	
Journal of Applied Chemistry (USSR)	J. App. Chem. (USSR)
Journal of Technical Physics (USSR)	J. Tech. Phys. (USSR)
Legkaya Promyshlennost (Light Industry)	Legkaya Prom.
Shelk	Shelk
Swedish	
Svensk Kemisk Tidskrift	Svensk Kem. Tid.
Svensk Papperstidning	Svensk Papperstidn.
Teknisk Tidskrift	Tek. Tid.

ABSTRACTS

ANALYSIS: TESTING: LABORATORY METHODS

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Acetylation of Cellulose

A new method of acetylation of cellulose with acetyl chloride. P. V. Popov. *Doklady Akad. Nauk S.S.S.R.* **46**, 358–60 (1945); *Compt. rend. acad. sci. U.R.S.S.* **46**, 325–7 (1945) (in English) (through *Chem. Abstr.* **39**, 5075[3] (Nov. 10, 1945)).

Experiments with purified linters show that the oxonium complex (cf. *C.A.* **32**, 2130[5]) formed from dioxane and AcCl is a more effective acetylation agent than the ammonium complex from pyridine and AcCl. Phenetole and nitrobenzene exhibit a limited tendency to promote reaction between linters and AcCl.

Text. Research J. Feb. 1946

Butyl Acetyl Ricinoleate

Butyl acetyl ricinoleate. C. Soyka and H. F. Wilson. *Brit. Plastics* **17**, 433–42 (Oct. 1945).

Butyl acetyl ricinoleate samples are analyzed by vacuum distillation and the fractions are evaluated for their plasticizing action on polyvinyl chloride. The existing methods of estimating butyl acetyl ricinoleate are critically discussed.

Text. Research J. Feb. 1946 E. F. Evans

Filter Paper

Methods for the evaluation of analytical filter papers. B. W. Scribner and W. K. Wilson. *J. Research Natl. Bur. Standards* **34**, 453–8 (May 1945).

As part of an investigation of analytical filter papers for the purpose of assisting in the development of standards of quality, improved methods for rate of flow of water, retention of fine precipitates, and determination of ash were developed. The use of complicated apparatus for measuring the rate of flow of water was avoided by applying Darcy's law to the ordinary conical filter. The use of prefiltered water in making the measurement was found necessary for satisfactory reproducibility. Because the standard method for determining the ash content of paper is not sufficiently accurate for filter paper, this method was modified in that a tare crucible is used and the test specimen is wetted and pressed into a compact wad to permit the use of as small a crucible as possible. The other tests were bursting strength of wet paper, thickness, weight per unit area, alpha cellulose, copper number, and acidity (pH). The last three named are of importance to the purity of the cellulose and the stability of acid-washed papers, as instances of deterioration of the cellulose of such papers have been observed. Action of acid results in brittling of the papers and in the formation of modified forms of cellulose that are soluble in some solutions. Author

Text. Research J. Feb. 1946

Determination of Hydroxyl Groups

Microdetermination of hydroxyl content of sugars and glycosides. Bert E. Christensen and Roy A. Clarke. *Ind. Eng. Chem., Anal. Ed.* **17**, 265 (Apr. 1945).

The method of Peterson, Hedberg, and Christensen for alcohols, phenols, etc. (*Ind. Eng. Chem., Anal. Ed.* **15**, 225, 943) is modified in two respects for use with sugars and glycosides. Double the amount of pyridine is used and the reaction time is extended to 48 hours.

A. R. Macmormac

Text. Research J. Feb. 1946

Determining the hydroxyl content of certain organic compounds—macro- and semimicro-methods. C. L. Ogg, W. L. Porter, and C. O. Willits. *Ind. Eng. Chem., Anal. Ed.* **17**, 394–7 (June 1945).

A modification of macro-procedures for determining the hydroxyl content of hydroxylated fatty acids and alcohols is described, in which an internal indicator is used. For colored solutions a potentiometric method has been developed. A semimicro-procedure using an internal indicator is also presented. An acetylating solution of 1 volume of acetic anhydride in 3 volumes of pyridine and a hot-water hydrolysis are used. A. R. Macormac

Text. Research J. Feb. 1946

Identification of Naphthol Dyes

Identification of sulfonated azo-2-naphthol dyes. Robert F. Milligan, Samuel Zuckerman, and Louis Koch. *Ind. Eng. Chem., Anal. Ed.* **17**, 569–70 (Sept. 1945).

A rapid and simple method has been developed for the identification of sulfonated azo-2-naphthol dyes by catalytic reduction of the azo bond, and the separation of the scission products with ethanol. Equivalent weight determination of the aminosulfonic acid and its conversion to the S-benzyl isothiourea derivative enables the analyst to differentiate between isomeric compounds. The method is not applicable to mixtures.

Text. Research J. Feb. 1946 Author

Molecular Weights of High Polymers

Molecular weight averages obtained from sedimentation velocity and diffusion measurements. Seymour Singer. *Polymer Bulletin* 1, 79–85 (Oct. 1945).

In the determination of average molecular weight of poly-disperse systems by sedimentation velocity measurements, the frictional coefficient is obtained by independent diffusion measurements. According to the hydrodynamics of Kuhn and Kuhn, the frictional coefficient is proportional to the length (or molecular weight) of uncoiled molecules, to the square root of the

molecular weight for highly coiled molecules holding solvent and to the cube root of the molecular weight for spherical molecules. Using the Lansing and Kraemer distribution function the authors calculate average molecular weights for the 3 types of molecules, assuming that both the sedimentation constant and diffusion constant are functions of the weight, number, or "Z" averages. Most of the resulting 9 calculated averages fall between the number and weight averages. The authors conclude that the average molecular weight obtained from sedimentation velocity is not a simple average and will depend on the hydrodynamic character of the molecules. However, the more compact the molecule, the higher will be the average molecular weight. E. D. Klug

Text. Research J. Feb. 1946

Irregularity Tester

The deviometer—an irregularity tester. R. W. Vose and C. H. Plummer. *J. Text. Inst.* **36**, T177–84 (July 1945).

A detailed description is given of an apparatus arranged to estimate the irregularity in sliver, roving, or yarn, etc., as reflected in the varying of the distance between two grooved wheels pressing the material from either side with a given force. This distance is used to actuate an electronic circuit which in turn controls electric meters connected in a manner to record the desired averages. In this manner automatic operation is secured, without need of cutting and weighing, etc., and without the many readings usually necessary "in order to place the scientific work on a footing which will enable it to compete with the art of the practical mill man." Preliminary applications include determining the shortest length of sample which could be used reliably in routine work and evaluating the proper roll spacing in a laboratory draw frame. G. Halsey

Text. Research J. Feb. 1946

Sliver and Yarn Regularity Tester

An automatic sliver and roving regularity tester and an automatic yarn regularity tester. S. L. Anderson, B. Cavaney, G. A. R. Foster, and J. R. Womersley. *J. Text. Inst.* **36**, T253–66 (Oct. 1945).

In this paper 2 testing instruments for the rapid measurement of the irregularity of cotton slivers, rovings, and yarns are described. Each of these is a development of the corresponding photographic regularity tester combined with a calculating machine in such a way as to render the measurement and calculation of the irregularity almost completely automatic. The instruments have attachments for controlling an integrator electrically from the testing instrument, thereby making possible the automatic calculation of irregularity. The speed of testing is still further increased by constructing a battery of testers, mounted on a common base, and having a common drive. The complete battery of 6 yarn testers, as described in this paper, takes 23 observations a min. on each cop. Thus, the standard number of observations per cop, 360, is completed in 16 min. In this time, each of the 6 units calculates the sum of 360 observations of thickness and also the mean square deviation of the observations from an arbitrary 0. Detailed drawings of the roving tester are given, including the electrical circuit. A. R. Martin

Text. Research J. Feb. 1946

Determination of Sulfur in Viscose

Determination of total sulfur and of the gamma number of viscose. Henry L. Barthelemy and Loveleen Williams. *Ind. Eng. Chem., Anal. Ed.* **17**, 624–6 (Oct. 1945).

A procedure is described for the rapid volumetric determination of carbon disulfide combined in viscose. The sulfur in all forms, whether combined as sodium cellulose xanthate, sodium thiocarbonate, or sodium sulfide, is quantitatively transformed into zinc sulfide in the presence of sodium zincate. The zinc sulfide is then titrated iodometrically in the presence of an excess of sulfuric acid. The method is modified to determine the viscose gamma number by titrating the by-product sulfur separately after salting out the sodium cellulose xanthate. Authors

Text. Research J. Feb. 1946

Weight Variation in Rovings and Yarns

The measurement of the weight variations in cotton, roving, and yarn. B. Cavaney, G. A. R. Foster, and J. Gregory. *J. Text. Inst.* **36**, T197–212 (Aug. 1945).

A method for calculating the variation in weight of yarns and roving by measuring thickness variations has been devised. The thickness of the yarn is measured by passing it through a photographic yarn regularity tester. Mean thickness of yarn from three equally spaced observations within a $\frac{1}{2}$-in. length was measured by use of a modified form of the tester. The weight is correlated with the thickness by cutting the yarn into equal lengths corresponding to those measured. These cut lengths are weighed. The weight variation is determined by means of the formula $W = adb$, where W = weight, d = thickness under compensation of 1 g. and a and b are constants derived from the data. The thickness of roving is measured in much the same way between wheels, values being determined for specimens $\frac{1}{8}$ in. long. For roving, a force of 7 kg. is used in order to get reliable observations. The results are, for yarns and rovings, considered mathematically by calculating the standard deviation of thickness. It is pointed out that since a large number of observations are required in order to get accurate estimates of the standard deviation, a method has been adopted which adjusts the conditions of testing to give a high correlation between thickness and weight per unit lengths and to find the relationship between thickness and weight on a comparatively small number of specimens by mathematical means. R. H. Armitage

Text. Research J. Feb. 1946

CHEMICAL AND PHYSICAL RESEARCH

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Absorption

Absorption of water by wool. A. B. D. Cassie. *Trans. Faraday Soc.* **41**, 458–64 (Aug.–Sept. 1945) (through *Bull. Inst. Paper Chem.* **16**, 117 (Nov. 1945)).

It is shown that the water vapor pressure isotherm of wool is greatly influenced by the hydrostatic pressure on the sorbed water as a result of the mechanical properties of the fibers. An isotherm reduced to one hydrostatic pressure is given, which does not show the sigmoid inflexion of the experimentally observed curve. An investigation of the absorption-desorption hysteresis of wool suggests that this is largely caused by the mechanical hysteresis of the fibers. The isotherm reduced to one hydrostatic pressure is analyzed using the theory of multimolecular absorption. Agreement of the theory and experimental observations is excellent, and it is shown that there are, on the average, 1.12 molecules of low energy sites per 100 g. of wool. This is close to the number of molecules, 1.11, of CO-groups per 100 g. of wool, and it is suggested that the CO-groups are primarily the water-attracting groups in wool. The heat of absorption of water on the sites is 3,500 cal./mol. 14 references.

Text. Research J. Feb. 1946

Adsorption of Proteins

Reversible adsorption of proteins at the oil/water interface. I. Preferential adsorption of proteins at charged oil/water interfaces. J. J. Elkes, A. C. Frazer, J. H. Schulman, and H. C. Stewart. *Proc. Roy. Soc.* **A184**, 102–15 (July 23, 1945).

The proteins studied (albumin, α, β and γ globulin and hemoglobin) were found to be adsorbed on charged oil/water interaces from solutions on the proper side of the iso-electric point, the proper side being, of course, acid for a negatively charged interface and alkaline for a positively charged one. For γ globulin, the pH ranges for flocculation of positively and negatively charged emulsions were found to overlap. However, this protein was dispersed in a solution containing 0.6% NaCl, and it was found that when NaCl was added to solutions of the other proteins the same overlapping occurred. The amount of protein necessary to give complete flocculation with a clear subnatant liquor and no separation of oil from the floccules corresponded to a monolayer of protein on the interface. With smaller amounts of protein, oil separated from the floccules, while with larger amounts more protein was adsorbed on the interface, up to 10 layers. It was also found that less protein was required for complete flocculation when NaCl was present. The adsorption of protein was found to be reversible, at least with hemoglobin, which could be adsorbed on a negative interface at pH 5 and desorbed, with redispersion of the emulsion, at pH 10. After such adsorption and desorption, the hemoglobin was found to have been converted to parahematin. It was also found possible to achieve separation of two proteins (albumin and hemoglobin) by differential adsorption on a charged interface. W. E. Davis

Text. Research J. Feb. 1946

Separation of Carbohydrates by Absorption

Chromatography of carbohydrates and some related compounds. B. W. Lew, M. L. Wolfrom, and R. Max Goepp, Jr. *J. Am. Chem. Soc.* **67**, 1865 (Oct. 1945).

Carbohydrates and related polyhydroxy compounds have been separated by chromatography using as an absorbent a Florida clay. Low molecular weight hydrophilic solvents were used as developers and alkaline permanganate, 2.6 dichlorophenolindophenol, or acid-base indicators were used as streak reagents. Water was the eluting agent. The series includes 3 pentoses, 9 hexoses, 2 heptoses, 6 disaccharides, 2 trisaccharides, 4 glycosides, 20 polyhydric alcohols and 10 acids, lactones, or salts. Several examples are given.

A. R. Macormac

Text. Research J. Feb. 1946

Cellulose From Softwoods

Fibrous holocellulose from softwoods. Edwin L. Lovell. *Ind. Eng. Chem.* **37**, 1034–7 (Nov. 1945).

Holocellulose was prepared from western hemlock and slash pine by four successive treatments with acetic acid solution of sodium chlorite at temperatures starting from 65° C to 74° C. The holocellulose from slash pine showed a maximum solubility in 7.5% NaOH. Treatment of both holocelluloses with 18% NaOH indicated about 75% alpha-cellulose, no beta-cellulose, and about 25% gamma-cellulose.

A. R. Macormac

Text. Research J. Feb. 1946

Degree of Order in Cellulosic Structure

Hydrolysis and catalytic oxidation of cellulosic materials. Determination of structural components of cotton linters. R. F. Nickerson and J. A. Habrle. *Ind. Eng. Chem.* **37**, 1115–18. (Nov. 1945).

The hydrolysis and oxidation of cotton linters by hydrochloric acid and ferric chloride to give carbon dioxide was studied as a means of determining the composition of cotton linters. Moisture adsorption and insoluble matter recovered after hydrolysis-oxidation runs are recorded. The linters starting material appears to contain highly disordered (*I*), highly ordered (*II*), and transitional components (*III*) in amounts by weight of approximately 3, 94 and 3%. *I* quickly hydrolyzes to glucose and is the most hygroscopic portion, apparently absorbing one molecule of water per hydroxyl. It plays an important part in the structure of the cotton linters since its removal reduces the linters to a coarse powder. *II*, which may be considered as the crystalline portion, composes the bulk of cotton linters. It is resistant to hydrolysis and

relatively homogeneous. *III* is intermediate in hydrolytic susceptibility and is more heterogeneous than either of the other portions. It more nearly resembles *II* than *I*. Further powdering of linters occurs when *III* is removed.

A. R. Macormac

Text. Research J. Feb. 1946

Color and Constitution

Color and constitution. VII. Interpretation of absorptions of dyes containing heterocyclic nuclei of different basicities. L. G. S. Brooker, A. L. Sklar, H. W. J. Cressman, G. H. Keyes, L. A. Smith, R. H. Sprague, E. Van Lare, G. Van Zandt, F. L. White, and W. W. Williams. *J. Am. Chem. Soc.* **67**, 1875–89 (Nov. 1945).

Optical data are given for 38 symmetrical carbocyanine dyes, 42 unsymmetrical pyrrolocarbocyanine dyes, and 36 styryl dyes. Details of dye syntheses are given for 80 of the dyes. The order of increasing deviation of $\lambda_{max.}$ for the unsymmetrical pyrrolocarbocyanine and the styryl dyes shows good agreement for a wide variety of heterocyclic radicals. Increasing deviation in either of these two series of dyes is attributed to increasing "basicity" of the variable heterocyclic nucleus. "Basicity" is defined as the relative attraction of the uncharged form of a ring for a positive charge. Using the conventional arguments of the resonance theory, this relative attraction is discussed in the terms of relative stabilizations of the net charged and uncharged forms of the nuclei. Good agreement between data and theory is found in most cases. A. R. Macormac

Text. Research J. Feb. 1946

Color and constitution. VIII. Absorption of unsymmetrical carbocyanines. L. G. S. Brooker, R. H. Sprague, and H. W. J. Cressman. *J. Am. Chem. Soc.* **67**, 1889–93 (Nov. 1945).

Nine different heterocyclic nuclei, ranging in basicity from quinoline to pyrrole, have been combined in all possible arrangements to give 36 unsymmetrical carbocyanines. The 10 unsymmetrical carbocyanines obtained by combining *N*-ethyl-substituted 2- and 4-quinoline. *B*-naphthothiazole, benzothiazole, and benzoxazole in all arrangements show negligible deviations (the calculated $\lambda_{max.}$ minus $\lambda_{max.}$, the observed value) of 35 Å. or less. If these 5 nuclei are combined with *N*-ethyl-3,3-dimethylindolenine, however, deviations ranging from 65 to 220 Å. are obtained, and these figures are increased when the 5 are combined with progressively fewer basic nuclei. The greatest deviation obtained is 725 Å. Many of the data illustrate the sensitivity rule but exceptions are noted. Authors

Text. Research J. Feb. 1946

Contact Angle

Large contact angles of plant and animal surfaces. A. B. D. Cassie and S. Baxter. *Nature* **155**, 21–2 (Jan. 6, 1945).

The apparent contact angle for water on a rough surface, where much air may be entrapped at the interface between the water and the solid, is given by

$$\cos \theta_D = f_1 \cos \theta - f_2,$$

where θ_D is the apparent or observed contact angle, θ is the true angle, f_1 is the area of solid-water contact, and f_2 is the area of air-water contact per unit superficial area of the interface. H. W. Theller

Text. Research J. Feb. 1946

Elasticity of Fibers

A comparison of the tensile elasticity of some textile fibers. Reginald Meredith. *J. Text. Inst.* **36**, T147–64 (July 1945).

The elasticity (ability to regain shape after deformation) of several fibers, whose stress-strain properties had been investigated in earlier work (*Shirley Inst. Mem.* **19**, 5 (1944)), is determined. In an introduction, the various previous papers are reviewed, and methods of determining elasticity are discussed. The method adopted is to measure the amount of recovery at any stress or strain with an arbitrary time cycle. The fibers were loaded and unloaded in steps of about 0.5 g. per den. up to the breaking stress. The experiments were conducted at a constant rate of loading of 10 g. per den. per min., followed by a period of constant load of $\frac{1}{2}$ min., unloading at the previous rate, and, finally, no load for 1 min. In preliminary tests on nylon, the following conclusions were reached: (*a*) Varying the time which the maximum stress was allowed to act on the fiber lead to the conclusion "that a long time would be required to establish equilibrium of stress and strain and the duration of half a minute chosen was the minimum time required to attain a reasonable approach to equilibrium, considering at the same time the length of the test." (*b*) By varying the time of recovery "the conclusion was drawn that a long duration of recovery was desirable, but one minute appears reasonable to limit the time of the test. (*c*) Results showed that the magnitude of the steps of imposed extension had no effect on the measured value of the elastic recovery." A number of cycles at a given stress was accompanied by a decrease of the elastic recovery. The elastic recovery of five varieties of cotton show that the relationship between elasticity and strain is practically independent of variety. Finer cotton showed a higher elasticity for a given stress. Five bast fibers were investigated. Jute was of interest, showing a slight *increase* in recovery with stress or strain. A group of 6 viscose rayons showed similar properties to be striking because "substantially perfect elasticity was maintained up to stress not greater than 50% of the yield stress." Three acetate samples showed a sudden decrease from almost perfect elasticity to very poor elasticity as the yield stress was passed. Four stretched rayons "retain a remarkably high elasticity up to rupture." Cuprammonium, nitro-, and resin-treated rayons showed high elasticity up to rupture. Three samples of silk showed similar slow decreases in elasticity with increasing stress, while Tussah silk showed

a sudden decrease at the yield point. Two vinyon samples were also studied. Two samples of nylon showed outstanding elasticity. Camel's hair showed considerably more elasticity than 3 wools, while mohair was quite similar to wool. Casein showed very poor elasticity. In comparison, nylon is the most elastic fiber. Stretched rayon and flax showed high recovery at high stresses, but not at high elongation, because of their stiffness. Silk is similar but inferior to nylon. Wool and hair showed high recovery from large strains, but because of their weakness they are poorer with respect to large stresses. Casein is very inelastic. "A comparison of cotton and rayon shows that the order of elasticity for a given stress is cotton, viscose rayon, and acetate rayon, but this order is reversed for a given strain." The difficulty of characterizing elasticity with a single constant was observed, but a collection of average values of elastic recoveries is given for the various fibers. A concluding section discusses previous work in the light of the present study.

Text. Research J. Feb. 1946 G. Halsey

Fiber Properties

Mechanical properties of textiles, III. Henry Eyring and George Halsey. TEXTILE RESEARCH JOURNAL **16**, 13–25 (Jan. 1946).

Continuing with subject of the first paper of this series, the authors discuss the processes of fiber breaking and their implications with respect to deformation. Breaking is shown to involve as the limiting process the flow of secondary bonds. From this standpoint the molecular meaning of the three-element model is discussed. The treatment of this model for a general restraint that includes constant rate of loading, elongation, and the pendulum tester is given. The calculation of toughness and the effect of the values of the model constants on the practical properties of the fiber are presented. Experiments at different rates of elongation are predicted. In conclusion, methods are given for the prediction of complicated experiments of the repeated loading cycle type, and data from the literature on this type are fitted. Thus certain concepts of strain-hardening and conditioning are clarified.

Text' Research J. Feb. 1946 G. Halsey

Hollow Spaces in Fibers

The microscopic detection, by dyeing, of hollow spaces in artificial fibers of cellulose hydrate, and the shape, nature, and formation of these hollow spaces. Albert Feubel. *Melliand Textilber.* **25**, 162–3 (1945) (through *Chem. Abstr.* **39**, 5080[5] (Nov. 10, 1945)).

The hollow spaces which become microscopically visible after dyeing with Victoria Blue 4R are small in number in cuprammonium rayon and have no appreciable effect on the depth of the total dyeing. The variation in dyeing and mordanting tendencies of the hollow spaces in cuprammonium rayon is attributed to a dense wall about the hollow space, the density being regulated by the extent of drying, which encloses the hollow space like a membrane. This inner membrane explains the delayed diffusion during dyeing and the possibility of removing the dye completely from the other parts of the fiber. Likewise the hydrolytic degradation and the retention of metal hydroxides in the hollow spaces cannot be explained without membrane action. The fact that final drying of cuprammonium rayon under practical operations is always carried out with a fat-containing brightening agent, since during the boiling with soap a small amount of fat is always retained by the hollow spaces, favors the industrial dyeing of the fiber according to the Victoria 4R method.

Text. Research J. Feb. 1946

Fluorescence

Fluorescence of organic dyes as related to chemical constitution. P. P. Feofilov. *Doklady Akad. Nauk S.S.S.R.* **45**, 387–90 (1944); *Compt. rend. acad. sci. U.R.S.S.* **45**, 367–70 (1944) (in English) (through *Chem. Abstr.* **39**, 4802[5] (Nov. 10, 1945)).

Strong fluorescence may be imparted to non-fluorescent triphenylmethane (TPM) dyes either (1) by formation of a chemical bridge between 2 of the benzene rings—i.e., by conversion to acridine, xanthene, or similar dyes—or (2) by incorporating the TPM dyes in rigid solutions—e.g., sugar, plastics, boric acid—or (3) by fixation on certain absorbents. These methods of imparting fluorescence are effective with all dyes—e.g., auramine, diphenylmethane, TPM, cyanine, pineverdol, dicyanine—whose structure permits relative rotation of two large parts of the molecule about a chain of conjugated double bonds responsible for the color of the dye. It is suggested that the above-mentioned methods for imparting fluorescence are effective because they prevent aromatic groups in the dye molecule from undergoing an angular shift in position about the ethylene double bond in the excited state. Suppression of such rotation in effect seals energy within the molecule and thus makes the energy available for emission as fluorescent light.

Text. Research J. Feb. 1946

Copper-Tolerant Fungi

Observations on the growth of some copper-tolerant fungi on cotton fabrics. C. H. Bayley and M. W. Weatherburn. *Am. Dyestuff Reptr.* **34**, 247–8 (June 18, 1945).

Qualitative observations on their growth on light cotton fabric containing copper naphthenate indicate that *Chaetomium globosum* and *Metarrhizium* are completely inhibited by a copper content in the fabric of 0.3% and 0.5%, respectively, as copper naphthenate, whereas the growth of *Aspergillus niger* is not inhibited over the whole range (0.005% to 0.8%) of copper content investigated. A potent cellulose-destroying species of *Penicillium* isolated from the soil has been shown to grow readily on samples of cotton fabric containing 0.3% copper, both with and without wax. The activity of this organism and also that of *A. niger* is inhibited by the presence of 0.3% copper in the form of copper naphthenate plus 0.1% of mercury in the form of mercuric naphthenate. Author

Text. Research J. Feb. 1946

Spectra of Dyes

Spectra of two diaminotriphenylmethane dyes derived from carbazole. J. E. K. Branch, B. M. Tolbert, and Warren Lowe. *J. Am. Chem. Soc.* **67**, 1693–1701 (Oct. 1945).

The dyes, *N*-dimethyl-*p*-aminophenyl-3-carbazylphenyl methyl chloride and 3,3′-dicarbazylphenylmethyl chloride, have been prepared and their absorption spectra examined. These dyes are analogs of malachite green with one and two *N*-dimethyl-*p*-aminophenyl groups replaced by the carbazyl radical. The spectrum of the symmetrical dye was independent of the solvent, but that of the unsymmetrical dye (monocarbazyl) varied with the solvent. Lambda X in chloroform was 629 mμ, in water 562 mμ. Lambda X was less and lambda Y greater than the corresponding bands of melachite green. The ultraviolet spectrum of the monocarbazyl dye in water showed an equilibrium between the benzenoid and quinonoid ions. In water solution the anhydro base of the monocarbazyl dye absorbed at a longer wave length than the dye itself. The relation between these spectra and those of malachite green and vividine green are discussed.

A. R. Macormac

Text. Research J. Feb. 1946

Infra-Red Spectra

The infra-red spectra of compounds of high molecular weight. H. W. Thompson and P. Torkington. *Trans. Faraday Soc.* **41**, 246–60 (Apr.–May 1945).

The infra-red absorption spectra of polymeric materials consist essentially of bands which correspond to the absorption of characteristic vibration frequencies of the whole molecule, or of particular parts within it. Chain branching in polythene can be detected by a band characteristic of methyl groups, and the method has also revealed a small amount of carbonyl in some polythene samples. The spectrum of Buna 85 indicates that both 1–2 and 1–4 addition of the butadiene has occurred, and estimates can be made of the relative extent of each type. In polystyrene most of the aromatic groups are regularly spaced along the aliphatic chain as a result of head-to-tail addition. Sufficient data are not available to determine whether or not some head-to-head polymerization is also involved. The spectrum of a polymer always shows marked differences from that of its monomer, and this can be used for following the rate of a polymerization process, or for the determination of small amounts of residual monomer in the polymer. Infra-red spectroscopy can furnish information about the distribution of substituents along a chain, as in the chlorination of polythene. The band in polythene which results from the long carbon-carbon chain vibrations, and which appears with 4 or more carbon atoms, diminishes in intensity with increasing chlorination and entirely disappears when about 50% of chlorine by weight is present. The proportions of the components of copolymers, such as Buna S, can be determined from an examination of their spectra. The structure of phenol- and cresol-formaldehyde resins has been elucidated to the extent of determining the positions of linkages on the aromatic nuclei involved.

Text. Research J. Feb. 1946 H. W. Theller

Infra-Red Spectra of Polymers

The infra-red spectra of polymers and related monomers. I. H. W. Thompson and P. Torkington. *Proc. Roy. Soc.* **A184**, 3–20 (July 23, 1945).

By limiting study to the vibrational spectra and considering only the region 1–25 microns, it was found possible to obtain data which could be interpreted. Apparently, this is because the existence of recurring units in polymers leads to a grouping of oscillation frequencies, and because many of the vibrations of long-chain systems lie at longer wave lengths than the range examined. The present paper deals with hydrocarbon polymers such as polythene, hydrorubber, polyisobutylene, Buna rubber and polystyrene. The work on polythene showed the presence of side-chain methyl groups, an appreciable amount of residual unsaturation (C=C) and a few carbonyl groups. The bands due to C=C and C=O become quite strong on cracking polythene to lower molecular weight products; methyl groups are still present. Oxidation of polythene leads to a product in which C=O absorption is very strong, methyl groups are still present, the bands associated with unsaturation are weakened, and there is a possible indication of the presence of carboxyl groups. The various types of rubber were examined mostly in connection with the determination of methyl groups in polythene, but gave results which were of interest in themselves. The analysis is not complete, but showed, for example, the presence of 2 methyl groups on one carbon in polyisobutylene and the probability that the polymerization of Buna proceeded by both 1–4 and 1–2 addition. The spectrum of polystyrene was very complex; the vibration of the phenyl group was identified with certainty, and there was some indication that methyl groups might be present. An attempt to determine orientation of groups attached to the main chain in polythene by the use of polarized radiation on oriented films was unsuccessful, probably because the spectrum of polythene contains so few intense bands. W. E. Davis

Text. Research J. Feb. 1946

The infra-red spectra of polymers and related monomers. II. H. W. Thompson and P. Torkington. *Proc. Roy. Soc.* **A184**, 21–41 (July 23, 1945).

This paper presents data on a number of unsaturated halides and some of the corresponding polymers. A fairly complete correlation of spectra (including rotational features) with structure was found possible for the monomers, which included vinylidene chloride and bromide, vinyl chloride and bromide and chloroprene, with some limited data on a number of chlorinated paraffins. The polymers examined were polyvinyl chloride, polyvinylidene chloride, halothenes (chlorinated poly-

thene) and neoprenes. The spectra obtained for the polymers are not discussed. Since this paper was submitted, the spectra of vinyl fluoride and iodide have been measured, and a complete correlation of the spectra of all the vinyl halides and vinyl cyanide has been carried out and published elsewhere (*J. Chem. Soc.* **1944**, 303, 597, and *Trans. Faraday Soc.* (May 1945).

Text. Research J. Feb. 1946 W. E. Davis

Iron Pigments

Alkali resistance of the iron blues. Harris Holtzman, *Ind. Eng. Chem.* **37**, 855–61 (Sept. 1945).

By the addition of nickel salts during manufacture the alkali resistance of iron blues has been improved. Iron blues have been formulated as salts of a polynuclear "berlinic acid" $H(Fe''(CN)_6Fe''')$ but a review of the literature indicates that the composition of these blues is controversial. Methods of preparation of commercial blues are reviewed. Prussian, Turnbull's, and oxidized soluble blues were prepared sometimes with the addition of nickel salts and precipitated by the addition of Fe^{+++}, Ni^{++}, Co^{++}, Zn^{++} or Ag^{+}, and the alkali-resistance of the resulting insoluble blues determined. The presence of Ni and Co increased the alkali stability of the blues. The most stable blue was obtained by replacing 20% of the iron by nickel in the formulation of the soluble blue. It was stable up to 4–5 hrs. in 0.5 *N* Na_2CO_3. No general stoichiometry was found. It is suggested that the action of nickel may consist in the precipitation of adsorbed and peptizing polyvalent anions and that colloidal absorption is involved.

A. R. Macormac

Text. Research J. Feb. 1946

GR-S Latex

Incorporation of carbon black into GR-S latex on a production scale. R. L. Rongone, C. B. Frost, and G. H. Swart. *Rubber Chem. Tech.* **18**, 130–40 (Jan. 1945).

In an attempt to obtain higher production with existing equipment during the war, a study was made of the feasibility of adding carbon black directly to GR-S latex, which was available in large quantities. Laboratory investigation showed the necessity for a dispersing agent in preparing a slurry of carbon black in water; naphthalene sulfonic acid-formaldehyde condensation products, lignosulfonic acids, and glucoside extracts such as tannin and quebracho were found to be suitable. It was also found necessary to use enough dispersing agent to give fluidity and stability in a fairly concentrated slurry, but not so much as to retain a large amount of fines in the aqueous phase on coagulation. It was also found possible to use black dispersed in the usual way and flocculated with alum before it was added to the latex. A quick, one-step coagulation of the black latex and retention of moisture in the milled coagulum were found to give the best results. The testing of the procedure on a production scale and conversion of a conventional plant to the new process are described. In comparison with the conventional method of adding black during milling, the incorporation of black into latex was found to give an increase of about 35% in milling capacity, a 20% saving in power consumption, and a product of approximately equivalent physical properties.

W. E. Davis

Text. Research J. Feb. 1946

Structure of Latex

Morphology of latex particles as shown by electron micrographs. S. B. Hendricks and S. G. Wildman. *Rubber Chem. Tech.* **18**, 173–81 (Jan. 1945).

Observation of latices from 16 species of plants with the electron microscope confirms earlier conclusions as to the fluid and form-retaining characteristics of latex particles, which were based on light-microscope studies. The electron micrographs, examples of which are presented, also show that some latex particles are so small that they could contain only a few molecules. Objections to the older theory of the structure of latex particles (a surface film of gel rubber and an interior consisting of an emulsion of sol rubber) are pointed out, and it is suggested that the properties of the particles are adequately accounted for on the basis of a structure consisting of a network of intertwined rubber molecules, with the other latex components held in the meshes of the network.

Text. Research J. Feb. 1946 W. E. Davis

Theory of Light Scattering by Solutions

A classical theory of light scattering from solutions—a review. B. H. Zimm, R. S. Stein, and Paul Doty. *Polymer Bulletin* **1**, 90–119 (Oct. 1945).

A review of the theory of molecular weight determinations of long-chained molecules from measurements of the intensity of light scattered by their solutions. From measurements of angular distribution of intensity of scattered light, estimations of average linear dimensions are made and from measurements of depolarization of light, qualitative information on size and anisotropy is obtained. E. D. Klug

Text. Research J. Feb. 1946

Lignin Extraction

Extraction of lignin from hydrolyzed lignocellulose. Raphael Katzen, Frederick G. Sawyer, and Donald F. Othmer. *Ind. Eng. Chem.* **37**, 1218–22 (Dec. 1945).

The solubility characteristics of lignin present in acid-hydrolyzed lignocellulose were observed. Methanol was chosen as the most practical solvent for the separation and recovery of soluble lignin. Batch extraction experiments with methanol yielded lignin solutions of low concentration. The method of extraction, however, did not affect appreciably the nature of the lignin. 98% of the lignin extracted was recovered by concentrating the extract to 25% lignin content and precipitating in 3 parts of water per part of concentrate. Ternary equilibrium data were obtained for the system methanol-methanol-soluble lignin-insoluble lignocellulose. Application of continuous counter-

current extraction methods based on these data yielded extracts containing as high as 11% lignin. Higher concentrations were shown to be feasible by re-use of the extract on fresh lignocellulose feed. Calculations are presented, indicating a steam consumption of 2,500 lbs. for solvent recovery per 100 lbs. of lignin recovered. Actual methanol losses could not be determined in the apparatus used. Authors

Text. Research J. Feb. 1946

Peroxide Oxidation of Carbohydrates

The action of hydrogen peroxide on carbohydrates. John H. Payne and Luther Foster. *J. Am. Chem. Soc.* **67**, 1654–6 (Oct. 1945).

A quantitative investigation of the action of hydrogen peroxide on glyceric aldehyde, erythritol, *d*-arabinose, *d*-glucose, and sucrose shows that hydrogen is a characteristic reaction production in every case. A satisfactory reaction mechanism places the origin of the hydrogen in the formaldehyde produced in the oxidative degradation of the compounds. Glyceric aldehyde apparently undergoes a dismutation reaction in the presence of low concentration of hydrogen peroxide.

Text. Research J. Feb. 1946 Authors

Kinetics of Photographic Development

The charge effect in relation to the kinetics of photographic development. I. The general effect. T. H. James. *J. Franklin Inst.* 240, 15–24 (July 1945).

This paper is concerned chiefly with the variations in rate of photographic development which can be attributed to changes in the potential barrier opposing the entrance of the developer into the grain, although there is some discussion of various other aspects of the theory of development. Charge (potential barrier) effects are divided roughly into 2 groups: those produced primarily by over-all changes in the barrier, and those originating from a localized change in the barrier occurring in the vicinity of growing silver particles; only effects in the first group are considered in this paper. These include the salt effect, action of certain dyes, and effect of developer charge. Neutral salts act by depressing the charge on the gelatin (negative in alkaline solutions), thus reducing the potential barrier for negatively charged developers. This effect is shown to increase with increase in the charge on the developer. The dyes which show an accelerating effect on development (particularly with doubly charged developers) are cationic substances which are adsorbed on the bromide surface and reduce its negative charge. Finally, with regard to the charge of the developer itself, it is significant that no doubly charged developer has been found which, in the early stages of development, approaches the rates attained by the majority of the singly charged and uncharged agents.

Text. Research J. Feb. 1946 W. E. Davis

Polyethylene Oxide Condensates

Polyethylene oxide condensates—an aid in the spectrophotometry of dyestuffs. H. H. Taylor and F. T. Simon. *Am. Dyestuff Reptr.* **34**, 319–21 (Aug. 13, 1945).

The errors to which spectrophotometric measurement of dilute dye solutions are subject because of variations in pH, salt concentration, temperature, irradiation, ageing, etc., may be greatly minimized by the use in the solution of approximately 1% of a polyethylene oxide condensate. The latter substances (P.E.O.C.'s) exert a powerful stabilizing effect and are useful with vat as well as with direct dye solutions. Because of their dispersing properties they are also valuable in preparing acetate dyes for spectrophotometric measurements. Another use is to improve coupling speed and ageing qualities when naphthols are coupled for colorimetric determination. A bathochromic shift takes place with most dyes in the presence of a P.E.O.C. In the study of mixtures of dyes in solution, dye interaction frequently makes impossible the calculation of either component of the mixture. Although the use of 25% pyridine solution as has been proposed (Neale and Stringfellow, *J. Soc. Dyers and Colourists* **59**, 241, 1943) in such cases is a great improvement, a P.E.O.C. will give even better (substantially quantitative) results, is more easily handled, and is practically odorless. C.

Text. Research J. Feb. 1946

Polythene

The melting of polythene. R. B. Richards. *Trans. Faraday Soc.* **41**, 127–37 (Mar. 1945).

The melting points of polythene samples are normally 20–30° below the value expected for a pure linear paraffin of comparable chain length, the melting process extends over a much wider temperature range, and the solid is not entirely crystalline even at room temperature. Samples with the same average molecular weight, as indicated by intrinsic viscosities, can vary as much as 15° in melting point. These variations may be due to changes in molecular weight distribution and in the degree of chain branching. By an extension of the statistical thermodynamic treatment of Frith and Tuckett, an equation is derived for the variation, with temperature, of the degree of crystallinity of a long-chain linear paraffin containing various proportions of short-chain paraffinic liquids which are concentrated in the amorphous regions of the solid. From this equation a further equation is derived for the change of melting point with the proportion and molecular weights of the added liquid. The theoretical results are found to be in fair agreement with observed data for the depression of melting point by paraffins of various molecular weights. The theoretical results suggest that there should be a connection between the crystallinity, and hence the density, of the solid at ordinary temperatures and the melting point of the sample. This is shown to be in accord with observed data. The presence of side groups will have an effect similar to that of short molecules, and by

increasing the entropy of the amorphous regions will lead to a more amorphous polymer. Part of the variability in melting point and crystallinity in polythene is no doubt due to variation in the degree of chain branching. Author

Text. Research J. Feb. 1946

Hot Tensile Test for Rubber

A simplified hot tensile test for GR-S. H. A. Braendle, E. Valden, and W. B. Wiegand. *Rubber Chem. Tech.* **18**, 204–7 (Jan. 1945).

The test is carried out in an ordinary tensile tester, using a slight modification of the A.S.T.M. test-strip. A hot iron, thermostatically controlled at 220° F, is held manually against the test strip while stress is applied. This is the same hot iron which was demonstrated before the Division of Rubber Chemistry at the Buffalo meeting of the A.C.S., Sept. 10–11, 1942, as a means of measuring heat embrittlement. A few typical results of the test are presented.

Text. Research J. Feb. 1946 W. E. Davis

Esters of Simple Saccharides

Acetates, propionates, and butyrates of simple saccharides. Ivan A. Wolff. *J. Am. Chem. Soc.* **67**, 1623–4 (Sept. 1945).

Esters were prepared by acylation with a mixture of pyridine and the anhydride of the acid. The ester was separated and purified by a vacuum distillation of the excess reactants and volatile products. Properties of 22 esters are given.

A. R. Macormac

Text. Research J. Feb. 1946

Oxidation of Starch

Action of hydroxylamine on polysaccharides oxidized with periodic acid. Thomas Dillon. *Nature* **155**, 546–7 (May 5, 1945).

Starch oxidized with periodic acid quickly dissolves in boiling water or absolute alcohol on addition of an alcoholic solution of hydroxylamine. After solution of the starch is complete, except for a small residue, the solvent is evaporated off. Ether will extract glyoxime (yields to 30% of theoretical) from the residue after acidulation. H. W. Theller

Text. Research J. Feb. 1946

Stiffness Test

A low-temperature stiffness test for elastomers. R. E. Morris, R. R. James, and E. R. Evans. *Rubber Chem. Tech.* **18**, 192–203 (Jan. 1945).

The test, which consists of stretching a small specimen in cold air under a definite vertical load and measuring elongation, is described at length, and references to other tests are given. Advantages claimed for the present method include the possibility of determining set as well as stiffness, use of small samples, use of air rather than alcohol (which swells some elastomers) as cold-transfer medium, simplicity of construction and operation of both cold-generating and stiffness-measuring apparatus, use of a weight rather than a spring to apply load to specimen, thus eliminating need for frequent calibration, and the possibility of using the test also at room temperature or higher. A number of results obtained with the new apparatus, illustrating the precision of the test, are presented.

Text. Research J. Feb. 1946 W. E. Davis

Water-Vapor Permeability

Water-vapor permeability—what it is and how it works. William H. Aiken, P. M. Doty, and H. Mark. *Modern Packaging* **45**, 137–40, 166, 168 (1945) (through *Chem. Abstr.* **39**, 5125[3] (Nov. 10, 1945)).

The structure of film-forming materials, the measurement of permeability to water-vapor, the permeability constant, and the effect of plasticizers on the permeability constants are discussed. Data are given for cellophane, Pliofilm, polyethylene, Saran, polyvinyl chloride-acetate copolymer VYNW, 3-ply glassine, ethylcellulose, polyvinyl chloride, rubber, and polystyrene. For homogeneous films of identical chemical composition the permeability constant is independent of thickness and of the vapor-pressure difference. Pure cellulose is as good a barrier as cellophane at low relative humidities, but the increase of the permeability constant with humidity is much less for cellophane. The permeability constant is an exponential function of absolute temperature, $P = P_0 e^{-E/RT}$, where P is the permeability constant at T absolute, R is the gas constant (1.985), and E is the energy of activation, governs the sensitivity of the permeability constant to temperature. High values of E accompany crystallinity and low values of the permeability constant. Plasticizers generally do not greatly affect the permeability constant; there is no direct relationship between permeability and mechanical behavior.

Text. Research J. Feb. 1946

BLEACHING: DYEING: FINISHING

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Algosols

Algosols—the leuco esters of vat dyes and their applications. P. J. Choquette. *Rayon Text. Mo.* **26**, 335–7 (Oct. 1945).

A brief description is given of the properties and methods of dyeing and printing Algosols on wool, cotton, and rayon. A. R. Martin

Text. Research J. Feb. 1946

Antiswelling Treatment

Dyeing reactions for the recognition of antiswelling treatment of fibers of regenerated cellulose. F. Dittmar. *Melliand Textilber.* **25**, 205–6 (1944) (through *Chem. Abstr.* **39**, 5079[7] (Nov. 10, 1945)).

Cellulose fibers which have been rendered resistant to swelling have a decreased affinity toward dyes; use of this fact in the testing of antiswelling treatment is studied. It is recommended to remove sizes or soluble finishing agents by proper precleaning, dry, and treat for 5 min. with a cold 8–18% NaOH

solution to which Leophen K or other wetting agent has been added. Rinse cold or warm, acidify with dilute HCOOH, rinse, and dry. Dye with 0.2–0.5% Sirius Light Blue B using a 1:20 to 1:30 batch containing 0.5 g. Igepon/l. and 5–15% salt at a temperature from 40° to boiling. Dye for 30–60 min., rinse, and dry. The combined alkali-dyeing method is well suited for detection of CH_2O treatment of the fiber. Alkaline swelling combined with substantive dyeing is the most sensitive reaction. This method is less suited to quantitative evaluation of the swelling effect. However, if the procedure is followed carefully there is good agreement between decrease of swelling and the dyeing reacion. The alkali-dyeing method is well suited for the detection of the CH_2O treatment. Less alkali-resistant finishing methods, such as the Kaurit K-F and the Schubert F-K method, can be detected readily. Anti-swelling finishing can be recognized in the presence of waterproofing. The successive alkaline treatment, acidification, drying, and final dyeing make this a time-consuming procedure. Experiments were conducted with a series of dyes and reagents which are alkali-soluble. The best results were obtained with water-soluble dyes or mixtures—e.g., the IG solution, to which 8% NaOH is added. All these dyeing methods are limited to light color tones. Modifications of the procedure are suggested for darker shades. If fluorescent dyes or strongly fluorescing naphthol compounds are used, the estimation must be done under ultraviolet light.

Text. Research J. Feb. 1946

Dyeing of Cellulose

The dyeing of cellulose with direct dyes. Part I. A review of the literature. H. Alan Standing. Trans. Faraday Soc. **41**, 410–34 (July, 1945) (through *Bull. Inst. Paper Chem.* **16**, 95 (Nov. 1945)).

After a brief historical introduction, the author reviews the literature on the subject under the headings: the purification of direct dyes; the properties of aqueous solutions of direct dyes; the equilibrium absorption of direct dyes of cellulose; theories of equilibrium dyeing and substantivity; the kinetics of the dyeing process; and the present position of the diffusion theory. From this review, it may be seen that both the experimental and the theoretical investigations of the kinetics of dyeing are far less developed than those of equilibrium dyeing. Although there is strong evidence that the dye diffuses into the swollen cellulose phase, little is yet definitely established concerning the relative effects of adsorption, the particle size of the dye micelles, and of the interionic forces on the kinetics of dyeing. 119 references.

Text. Research J. Feb. 1946

The dyeing of cellulose with direct dyes. Part II. The absorption of Chrysophenine by cellulose sheet. Hector F. Willis, John O. Warwicker, H. Alan Standing, and Alexander R. Urquhart. *Trans. Faraday Soc.* **41**, 506–41 (Aug.–Sept. 1945) (through *Bull. Inst. Paper Chem.* **16**, 95–6 (Nov. 1945)).

Experimental work on the absorption of Chrysophenine by cellophane, determined over a wide range of temperatures and salt concentrations of the dyeing bath, is described. The data obtained satisfy a theory of dyeing, based upon the operation of attractive forces between the dye anions and the cellulose. The result of a calculation of the energy released in the dyeing process—namely, of 14 K. cal./mol. of pure dye absorbed—is not inconsistent with the assumption that each dye molecule is held to the cellulose by means of two hydrogen bonds. The theory is not applicable in its present form to dyes that aggregate in solution to form anionic micelles. On the other hand, some of the theoretical conclusions are applicable with a fair degree of success to earlier experimental data of Neale and co-operators for Benzopurpurine and some other direct dyes. Work with highly aggregated dyes is now in progress, and the results are expected to show how the theory may be modified to fit the system of such dyes. 11 references.

Text. Research J. Feb. 1946

The dyeing of cellulose with direct dyes. Part III. The aqueous diffusion of direct dyes. Frank H. Holmes and H. Alan Standing. *Trans. Faraday Soc.* **41**, 542–67 (Aug.–Sept. 1945) (through *Bull. Inst. Paper Chem.* **16**, 94 (Nov. 1945)).

The aqueous diffusion of Chrysophenine G (Colour Index 365) and Direct fast orange SE (Colour Index 326)—which exhibit markedly contrasting behavior with respect to their rate of dyeing on viscose rayon—was investigated. The diffusion coefficients of these dyes were determined at various temperatures and electrolyte concentrations and used to determine the degree of aggregation of the dye anions. It is shown that Chrysophenine is only slightly (see **Part II**), whereas Direct fast orange is appreciably, aggregated. Equivalent concentrations of different electrolytes with monovalent cations have approximately the same effect on the diffusion, but salts of bivalent cations have a more pronounced effect. Discrepancies are observed for the "mobilities" of the dye anions calculated from diffusion coefficients, which are determined by 2 different methods, and the reasons for these discrepancies are discussed. 27 references.

Text. Research J. Feb. 1946

The dyeing of cellulose with direct dyes. Part IV. The electrolytic conductance of aqueous solutions of direct dyes. Frank H. Holmes and H. Alan Standing. *Trans. Faraday Soc.* **41**, 568–74 (Aug.–Sept. 1945) (through *Bull. Inst. Paper Chem.* **16**, 94 (Nov. 1945)).

The conductance of the two dyes dealt with in the previous abstract and of Chlorazol sky blue FF (Colour Index 518) was determined and the data thus obtained were used to calculate the "aggregation numbers" by a method similar to that of Robinson and Garrett. The results obtained show that none of the three dyes can be consider-

ably aggregated in aqueous solution free from any other electrolyte unless their micelles contain a large proportion of cations.
Text. Research J. Feb. 1946

Wool Dyeing

Current aspects of interest in wool dyeing. H. E. Millson. *Am. Dyestuff Reptr.* **34**, P284–90 (July 16, 1945).

Three recent developments in wool dyeing are discussed—namely, minimum use of chrome in top chrome dyeing, dyeing with metallized dyes, and continuous dyeing. Experiments have clearly shown that in top chrome dyeing the bath must be kept at boiling temperature long enough for diffusion and equalization of the dye to take place before the chrome is added, and that maximum fastness properties will not be obtained unless sufficient bichromate is used to convert all of the dye in the fiber to the chromium complex. Factors bringing about these limitations in top chrome dyeing are preferential absorption, during the initial stages, of one dye out of a combination, and preferential chromation of the wool. The former effect results from the chemical nature of the dyes employed, whereas the latter is due to the heterogeneity of the wool fibers. Comparative brightness, level dyeing properties, and ease of application have increased the demand for metallized wool dyes (Calcofasts, Neolans, Palatines). However, leveling studies on these dyes indicate that maximum fiber levelness is obtained only after boiling 1½ hours or longer with 8% sulfuric acid. Continuous methods for the dyeing of wool, recent innovations in this branch of the industry, generally depend upon a short dyeing period. Although exhaustion of a dye bath can be accomplished in a short time, proper distribution and penetration of the color into the wool is much more difficult. One difficulty lies in overcoming the wide variation in affinity of different wools for dyes; certain dyes represent incompatibles in mixtures for continuous dyeing since they depress the rate and degree of exhaustion of other component dyes beyond the limits of the time cycle required. Selection of proper dyes for this type of dyeing is obviously of greatest importance. C.
Text. Research J. Feb. 1946

Dyes for Nylon

Dyestuffs for cellulose esters and polyamide fibers. S. Yates. *Silk J. Rayon World* **21**, 32–3, 38 (Oct. 1945).

Dyestuffs for coloring acetate rayon and other cellulose esters and ethers have taken on new significance in connection with the dyeing of polyamide fibers of the nylon type. The development of these dyes, including the Ionamines, S.R.A. dyes, Duranols, Dispersols, and Solacet dyes, is discussed and certain of their properties and constitutional features are reviewed. References to patents are included.
R. K. Worner
Text. Research J. Feb. 1946

Gas Fading

Gas fading of acetate rayon. Anon. *Dyer* **94**, 243, 245, 247 (Sept. 14, 1945).

A description of a patented method for inhibiting the gas fading of cellulose acetate which consists in pretreating the fabric at 770° F for 30 secs. with about 33% caustic soda.
Text. Research J. Feb. 1946 A. R. Martin

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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Flax in Australia

Australia's flax programme. Anon. *Fibres* **6**, 120–1 (Oct. 1945).

Developments in flax production and research in Australia are discussed on the basis of an article by W. L. Greenhill in the Commonwealth *Journal of the Council for Scientific and Industrial Research* **18**, 132 (May, 1945). Research has been conducted on retting and on the chemistry of the products of the flax plant, and an effort has been made to correlate various physical properties with fiber quality. A successful chemical retting process requiring only 8 hrs. has been advanced to the pilot plant stage after several years of research. Another research result has been the development of a freezing technique for preparing microscopic sections of flax straw. Opportunities for additional research on flax are seen in the fact that at present only about 50% of the fiber in the straw is recovered as long fiber.
Text. Research J. Feb. 1946 R. B. Evans

Phormium

Phormium. Anon. *Fibres* **6**, 128 (Oct. 1945).

Phormium, derived from *Phormium tenax*, or the harakeke lily, is a lesser-known fiber, native to New Zealand, where its use was traditional with the Maoris. It became an export fiber for cordage purposes in the latter part of the 19th century, but its use has declined in recent years because of competition from sisal, which has a superior breaking strength. It now is used in the manufacture of wool bags in New Zealand. Yield of fiber is 15% of the plant, which is much higher than that of sisal, but the residue is still large and efforts are being made to use it in the manufacture of alcohol and paper. There is a fair amount of literature concerning phormium but much of it is out of print. A study by Esmond H. Atkinson (*Bulletin 95* of the New Zealand Department of Agriculture) is mentioned. R. B. Evans
Text. Research J. Feb. 1946

Piteira

Piteira. Anon. *Fibres* **6**, 157 (Nov. 1945).

Piteira (*Furcraea gigantea willemettiana*) was cultivated by the Dutch in South America during the seventeenth century. It was introduced next to a number of other areas, including Mauritius, from which it is called "Mauritius hemp." It resembles sisal in method of cultivation and uses but is weaker and usually sells for about ⅓ less. Output has been nominal in recent years. R. B. Evans
Text. Research J. Feb. 1946

Spun Rayon

Processing procedures for spun rayon yarns. Leslie L. Cobb. *Cotton* **109**, 93–6 (Nov. 1945).

The blending, tinting, and picking of staple rayon is discussed rather completely. Included are a table showing average fineness of various cottons in denier, a table showing the finest yarns which can be spun practically from 10 synthetic blends, and a diagram showing fiber breakage on the card of 1.5-in., 2-in., and 2.5-in., 3-denier acetate.

H. J. Burnham

Text. Research J. Feb. 1946

Iron Yarn

The finishing of iron yarn. P. Hoffmann. *Wollen-u. Leinen-Ind.* **61**, 224–5 (1941); *Chem. Zentr.* **1941, II**, 2037–8 (through *Chem. Abstr.* **39**, 5082[7] (Nov. 10, 1945)).

Iron yarn is finished with a sizing solution to which fats, waxes, paraffin, or similar substance have been added. Hard fats improve the luster of the yarn. Japan wax and the I. G. waxes are suitable; also dextrin may be combined with starch and wax. Directions are given.

Text. Research J. Feb. 1946

Impregnated Fabrics

Laminated plastics, impregnated paper, and impregnated fabrics. Franck and Nagel. *German Tekh.* **20**, Sonderheft No. 2, 18–21 (1941); *Chem. Zentr.* **1941, II**, 1800 (through *Chem. Abstr.* **39**, 5549[8] (Nov. 20, 1945)).

Review of properties and applications of the impregnated paper "Presszell" and the textolite "Novotext."

Text. Research J. Feb. 1946

Serviceability of Marquisettes

The serviceability of curtain marquisettes. B. V. Morrison and V. C. Jelinek. *Am. Dyestuff Reptr.* **34**, 328–33 (Aug. 13, 1945).

In spite of a tremendous normal production of marquisette, of which a large proportion is used for curtains, there have been virtually no data available concerning its performance in service. A combined laboratory and service test over a period of a year has been made on this fabric made into glass curtains. The curtains were exposed uniformly in east windows, laundered every two months, and at 4-month intervals samples were taken for mechanical and physical tests. Data obtained showed that after service the average increase in cuprammonium fluidity and in the percentage loss in breaking strength for the unfinished cottons was less than for the finished (bleached and/or dyed) cottons. On the whole the rate of loss in breaking strength was greater during the first months of the study; the highest weight per square yard for the majority of the fabrics was recorded after the fourth laundering. Shrinkage in width exceeded that in length for all-cotton fabric, but the reverse was true in the curtains containing rayon. Marquisette woven from fine single yarns apparently does not make a highly serviceable glass curtain material. A high-count type made from all cotton or filament rayon yarns with relatively high twist should be chosen. C.

Text. Research J. Feb. 1946

Cotton Spinning

Cotton spinning. James H. Dawson. *Indian Textile J.* **55**, 713–6 (July 1945).

One of a series of articles on preparatory and spinning operations. The hopper bale breaker and feeder are described. R. K. Worner

Text. Research J. Feb. 1946

Picking Tappet

Design of a picking tappet. S. S. Ahluwalia. *Indian Textile J.* **55**, 717–20 (July 1945).

Detailed calculations are given for designing a picking tappet. The effects on it of picks per minute of the loom, weight and length of the shuttle, and reed space of the loom are discussed. R. K. Worner

Text. Research J. Feb. 1946

Swiss Textile Machinery

Novel ideas in Swiss textile machines. Ruti Textile Machinery Works, Switzerland. *Indian Textile J.* **55**, 646–8 (June 1945).

Improvements in automatic looms, beam warping machinery, creels, and hot-air drying and sizing machines are described.

R. K. Worner

Text. Research J. Feb. 1946

Fabric Shrinkage

Shrinkage of fabrics during raising. C. P. Atkinson and C. S. Whewell. *J. Text. Inst.* **36**, P156–7 (Oct. 1945).

In the course of a long investigation on the raising of textile fabrics, which will be described in a later paper, it was noted that a fabric which contained a nylon yarn in the weft became appreciably narrower and thicker during the raising process. This was at first attributed to the cloth being stretched lengthways, but on repeating the experiment accurate measurements revealed that the width shrinkage took place without a change in length. Moreover, contraction increased as the raising process was continued.

Text. Research J. Feb. 1946 J.

MISCELLANEOUS

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Color of Proteins

Improvement in the color of peanut and cottonseed proteins. T. D. Fontaine, S. B. Detwiler, Jr., and G. W. Irving, Jr. *Ind. Eng. Chem.* **37**, 1232–6 (Dec. 1945).

Data are presented to show that protein preparations can be obtained from the meals of white-skin peanuts and blanched red-skin peanuts, without the use of bleaching agents, that are as light or lighter in color than commercial samples of soybean protein. The color of proteins prepared from meals of unblanched red-skin peanuts and cottonseed is improved considerably through the use of controlled protein extraction and precipitation

techniques and by washing the moist protein precipitates with organic solvents such as dioxane, acetone, and methyl ethyl ketone. Procedures are given for obtaining, from meal of unblanched red-skin peanuts and from cottonseed meal, satisfactory yields of protein preparations that are lighter in color than those obtained heretofore from similar raw materials, and that approach in color very close to the range of practical usefulness for the production of adhesives and fibers. The use of heat in drying is shown to exert inappreciable influence upon the color of dried peanut protein.

Text. Research J. Feb. 1946 Authors

Leather-Resinoid

Thermoplastic leather-resinoid. A. Colin-Russ. *Brit. Plastics* **17**, 402–9 (Oct. 1945).

Thermoplastic resinoid from chrome leather is soluble in water and will emulsify almost all the usual plasticizers but is not plasticized by them. Similar leather-resinoid from vegetable tannages is incompletely miscible with water and is plasticized only by amides, simple glycols, and certain benzene derivatives. The mode of action of these plasticizers is discussed. E. F. Evans

Text. Research J. Feb. 1946

Thermoplastic Laminates

Cellulose compounds in thermoplastic laminates. C. W. Eurenius, R. H. Hecht, William Kock, and H. C. Malpass. *Ind. Eng. Chem.* **37**, 959–63 (Oct. 1945).

Thermosetting laminates have the disadvantage of requiring heat and pressure to polymerize the resins. Furthermore, being three-dimensional polymers, they have relatively low impact strength and must depend to a large extent on the filler for impact strength or shock-resistance. Cellulose acetate and ethyl cellulose, being thermoplastic, would not have these disadvantages. Laminates were made using cellulose acetate and ethyl cellulose with several types of cotton fabrics, glass fabric, asbestos paper, and kraft paper. They were found to possess an unusual degree of toughness and were readily drawn into complex shapes with inexpensive equipment when softened by heat. They can be quickly and easily fabricated and an unlimited range of color possibilities is available. Properties such as low-temperature flexibility, impact strength, modulus of elasticity, water absorption, and electrical insulation behavior can be controlled by proper selection of the bonding plastic and the filler material. A. R. Macormac

Text. Research J. Feb. 1946

Extraction of Vegetable Oils

Solvent extraction of cottonseed and peanut oils. E. F. Pollard, H. L. E. Vix, and E. A. Gastrock. *Ind. Eng. Chem.* **37**, 1022–6 (Oct. 1945).

The boiling points and densities of mixtures of cottonseed and peanut oils with commercial hexane are reported. They are useful in the design of vacuum evaporators and strippers and for control operations involving temperature, time of heating, and concentration of oil-solvent mixtures of various compositions to prevent or minimize fixation of objectionable coloring matter or other deteriorative heat effects. Boiling point data are determined at various concentrations of crude cottonseed oil and crude peanut oil, over a range of pressures from 160 to 760 mm. absolute in commercial hexane. The reported data should be of value in the further development of the technology of the solvent extraction of vegetable oils. Observations of the effect of agitation in establishing equilibrium conditions of the oil-solvent mixtures are noted. The Raoult law and the Duhring rule cannot be applied for predicting data of the necessary accuracy within the critical operating region. Authors

Text. Research J. Feb. 1946

New Textile Developments

Current textile progress. A. J. Hall. *Am. Dyestuff Reptr.* **34**, 340–3 (Aug. 27, 1945).

Recent patents are described for the following processes: animalizing viscose rayon staple by resin treatment in such a manner that the affinity for wool dyes thus attained is not lost in the alkaline wet processing customarily used on wool; manufacture of a disazo-type dye which when coppered provides a dye of excellent fastness properties and one which resists acetate rayon well; production of inter-polyamides (by reaction of two or more diamines with two or more dicarboxylic acids) with softening points which, though lower than those for nylon, are high enough to be technically useful, and of possible interest in the field of coated textiles because of their solubility in alcohol; and improvement of the wash-fastness of cellulose ethers, e.g., methyl cellulose, as textile coating materials by incorporating a methylated hexamethylol melamine resin. The problem of assessing damage in linen and flax materials is discussed and recent work in which pyrogallol and hydroquinone were found to be highly effective in eliminating serious oxidation of linen cellulose during filtration of its cuprammonium solutions is described. C.

Text. Research J. Feb. 1946

Numbering Systems

Weighing and measuring. Anon. *Textile Weekly* **36**, 924, 926, 928 (Nov. 16, 1945).

A report of an address by G. Moores to the British Association of Managers of Textile Works and of the discussion which followed in which various arguments are given as to why the present system of cotton counts should be kept.

H. J. Burnham

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Textile Mill Management

Postwar management and production shorts. Henry Miedendorp, Jr. *Rayon Text. Mo.* **26**, 507–9 (Oct. 1945).

Advantages of incorporating production and sales departments, and of central purchasing are cited. Training of workers under skilled operators in a pilot plant is ad-

vocated as a means of increasing labor efficiency. R. B. Evans
Text. Research J. Feb. 1946

Textile Nomenclature

Should nylon be called rayon? Where does existing nomenclature lead? Anon. *Silk J. Rayon World* **21**, 26–7 (Oct. 1945).

Arguments are given against the British Rayon Federation's all-inclusive definition for "rayon." Just as different words, such as cotton, wool, silk, etc., are used for natural fibers, several different words will be needed to identify the various man-made fibers. R. K. Worner
Text. Research J. Feb. 1946

Textile Weekly Index

Textile Weekly **36** (Nov. 16, 1945). Complete index of all articles published in Vol. 35, covering the period Jan. 5 to June 29, 1945. H. J. Burnham
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Employee Grievances

Handling employee grievances. G. R. Schenck. *Cotton* **109**, 110–12, 156 (Nov. 1945).

All employees grievances should be handled initially by immediate supervisors. Experience has shown that from 50 to 80% of all grievances can be settled at the foreman's level. Foremen should be selected for leadership as well as for technical skill, their authority should be clearly defined, and they should have a full understanding of company policies. Grievances should be handled on the basis of written policies, developed with the participation of all levels of management, providing for quick, sympathetic handling and for definite settlements. The personnel department should maintain a neutral position between labor and management.
Text. Research J. Feb. 1946 R. B. Evans

Indian Wool Industry

Indian wool industry—noteworthy experiment at Patan. M. H. Shah. *Indian Textile J.* **55**, 628–32 (June 1945).

An example is cited of the new interest in the Indian wool industry, and of efforts to produce a quality fiber in contrast to the usual carpet wools. Central India produces very fine quality wool. It is said that sheep from this area were imported into Australia in the past and that the Australian Merino evolved from them. R. K. Worner
Text. Research J. Feb. 1946

Hercules' Ethyl Cellulose Plant

Integration of chemical plant facilities. Anon. *Chem. and Met. Eng.* **52**, 129–36, 138–41 (Sept. 1945).

A description of the ethyl cellulose plant of the Hercules Powder Co. at Hopewell, Va. It consists of the following separate units: (1) caustic–chlorine plant, (2) linters purification, (3) ethyl cellulose production, (4) solvent recovery, (5) hydrochloric acid production, (6) conversion of by-product ethyl alcohol and ether to ethyl chloride. An ethyl cellulose flow sheet and pictures of plant operations are included. E. D. Klug
Text. Research J. Feb. 1946

Australian Textile Industry

Textile industry in Australia. H. Bowden Fletcher. *Rayon Text. Mo.* **26**, 506 (Oct. 1945).

Australian wool growers have agreed to a special tax of 30¢ per bale, to be matched by the government, creating an annual income of $2,000,000, of which 25% will be devoted to research and the remainder to promotional activities. Burlington Mills (Australia) has been organized to weave, dye, and finish rayon piece goods in a leased factory at Newcastle, Australia. It is planned to obtain raw materials from England and machinery from the United States. Production of 70,000,000 yds. annually, 40% of Australia's prewar rayon requirements, is expected. Expansion of cotton textile manufacture during the next 5 years also is predicted, with the object of increasing production to 100,000,000 lbs. of yarn and 92,000,000 sq. yds. of cloth annually, or 40% of Australian requirements.
Text. Research J. Feb. 1946 R. B. Evans

Brazilian Silk Production

Progress of Brazilian silk production. Excerpted from a Brazilian bulletin. *Rayon Text. Mo.* **26**, 534 (Oct. 1945).

Advantages of Brazil's climate for silk production are cited and progress in silk production and manufacture is noted. Reeled silk production in Brazil in 1945 approximated 1,102,300 lbs. as compared with 198,414 lbs. in 1942.
Text. Research J. Feb. 1946 R. B. Evans

Wool Marketing in Australia

Organized Marketing of export commodities in Australia: wool. Maurice E. Wright. *Foreign Agriculture* **9**, 162–4 (Nov. 1945).

Australia produces ¼ of the world's wool and about 50% of the world's production of fine merino wools. Practically all wool produced in Australia, New Zealand, and the Union of South Africa was marketed by public auction before the war. Growers in Australia forward their clip to a selling broker who provides storage space and display rooms, furnishes technical advice to growers, and handles their sales in the auctions. Except in 1921 and during this war, the entire clip has been marketed during the production season. In 1939, the United Kingdom agreed to pay the Commonwealth government a flat rate of 13.44 d. (Australian currency), or about 18¢, per lb. for the entire clip plus ½ of any net profit on sales to foreign countries. This price was increased to 15.5 d. (about 21¢) in 1942. Under a recent agreement of the United Kingdom with the wool-producing dominions, the auction system will be used for the sale of both new wool clips and accumulated surpluses, with provision for a fixed minimum price below which prices will not be allowed to fall. In 1936, the Australian government levied a tax of 6 d. (10¢) per bale (recently increased fourfold) on all wool shorn in Australia

for the benefit of the Wool Publicity and Research Fund. Research conducted in Australia has been concerned mainly with wool production, but some of the funds thus raised, with similar funds from New Zealand and the Union of South Africa, have been used to establish the International Wool Secretariat in London. This organization engages in publicity and scientific and economic research affecting the wool industry in the United Kingdom, United States, and continental Europe. R. B. Evans

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PATENT REFERENCES

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Knitted Goods

Knitted goods. Frank Headon. U. S. 2,388,144 (Oct. 30, 1945).

This invention relates to improved non-run knitted goods, including fabrics and articles made from yarns of organic derivatives of cellulose and more particularly to cellulose acetate yarn or yarn of material possessing some of the same general characteristics, such as the quality of being thermoplastic, and methods of treating knitted fabrics and articles made from such yarn, whereby the tendency to develop such faults as runs or laddering may be greatly reduced. P.T.I.

Text. Research J. Feb. 1946

Dyeing Nitrogenous Textiles

Method of dyeing woolen and other nitrogenous textile materials. Harold J. Walter (to Uxbridge Worsted Co., Inc.). U. S. 2,387,-200 (Oct. 16, 1945).

A method of dyeing textile fabrics of wool, etc., in open width under pressure at temperatures above 212° F in a period of $\frac{1}{4}$ min. to 5 min. and requiring no further ageing to fix the dye, a temperature of 295° F being the upper limit. A machine to accomplish this is described in detail. There are 11 claims. P.T.I.

Text. Research J. Feb. 1946

Knitting Machines

Forming of welts in straight knitting machines. Hans J. Strauss-berger (to Alfred Hofmann, Inc.). U. S. 2,387,780 (Oct. 30, 1945).

The general objects of the present invention are to afford a more satisfactory and practical method for forming welts in hosiery, to provide a novel welt hook useful for said or similar methods, and to produce an improved product or structure of fabric. P.T.I.

Text. Research J. Feb. 1946

Circular knitting machine and method of operating same. Albert E. Page and Frank R. Page (to Scott & Williams, Inc.). U. S. 2,387,769 (Oct. 30, 1945).

The means for maintaining the registry between the transfer implements and loops and the needles to receive the loops is one of the principal objects of this invention. It is of interest to note that this is done without introducing any new knitting elements in the machine. The basic features of the present invention are applicable to a machine of any gage making any kind of a transferred stitch. P.T.I.

Text. Research J. Feb. 1946

Knitting method and machine. James L. Getaz (to Scott and Williams, Inc.). U. S. 2,387,253 (Oct. 23, 1945).

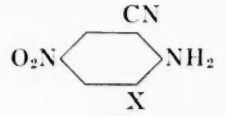
It is the broad object of the present invention to provide a method and means for insuring proper wrapping on as many needles as possible forming a broad rib. P.T.I.

Text. Research J. Feb. 1946

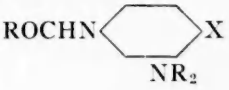
Printing

Discharge printing of cellulose acetate. George W. Seymour and Victor S. Salvin (to Celanese Corp. of America). U. S. 2,385,-885 (Oct. 2, 1945).

This patent is relevant to the discovery that both white and colored discharge prints may be obtained in a single operation with alkaline discharging agents such as sodium sulfoxylate formaldehyde mixed with sodium thiocyanate, thickener, caustic soda and water, on textile fabrics containing cellulose acetate, nylon, and other materials of similar chemical nature dyed with azo dyes obtained by diazotizing an amino compound of the general formula:



and coupling with a substituted dihydroxyalkyl-amino compound of the following general formula:



wherein R = hydroxylalkyl group containing two or more carbon atoms, R' = an alkyl group, and X = may be H, alkyl, O-alkyl, or O-alkylene —OH. The fabric is dyed, printed, dried, aged in a rapid ager 14 min. at 100° C in the conventional manner, then aftertreated 2 min. in a caustic soda solution (2 g./l.) and washed. If vat colors are present, they are oxidized by treating the fabric in 5 g./l. sodium perborate and 1 g./l. soap for 2 min. at 50° C. Then the material is thoroughly rinsed and dried. P.T.I.

Text. Research J. Feb. 1946

Yarn Feed Control

Yarn feed control means for textile machines. Pacific J. Thomas (to U. S. Textile Machine Co.). U. S. 2,386,822 (Oct. 16, 1945).

This patent concerns yarn twisting and winding machines of the type commonly referred to in the trade as "up-twisters," and is intended to provide a means for maintaining them at high operating and output efficiency during the twisting and winding of certain yarns which have a tendency to break when subjected to the normal, or usual, operations and conditions of such machines.

Text. Research J. Feb. 1946 P.T.I.